Final Report:

SNaP

A Survey of *Native Proppant* Resources within Montana

Funded by:

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Montana Tech and the Montana Bureau of Mines and Geology

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Overview

A joint project between academic units of Montana Tech and the Montana Bureau of Mines and Geology (MBMG) investigated the potential of Montana natural sands for use as proppant in hydraulic fracture stimulation. The MBMG oversaw field sampling and development of a public-access database; Montana Tech conducted the laboratory analyses and generated the reports.

This three-year project, titled *A Survey of Native Proppant Resources within Montana* (SNaP) was funded by the Montana Board of Oil and Gas Conservation and was carried out from 2013 through 2015. The goal of the project was to characterize sandstone formations throughout the state for potential use as proppants applicable to hydraulic fracturing of oil and gas wells.

A total of 351 samples were collected across the state (Figure 1). Not all of these samples are in the data base for reasons ranging from the sample being too small to test to contributions that were not sandstone. The SNaP public-access database (http://data.mbmg.mtech.edu/proppant/Data.asp) from which Figure 1 was generated, provides test results and pictures for each sample. In addition, the SNaP data set includes sandstone descriptions from measured sections (Appendix E) obtained from geological publications, dissertations, and theses. (References are listed in Appendix D.)

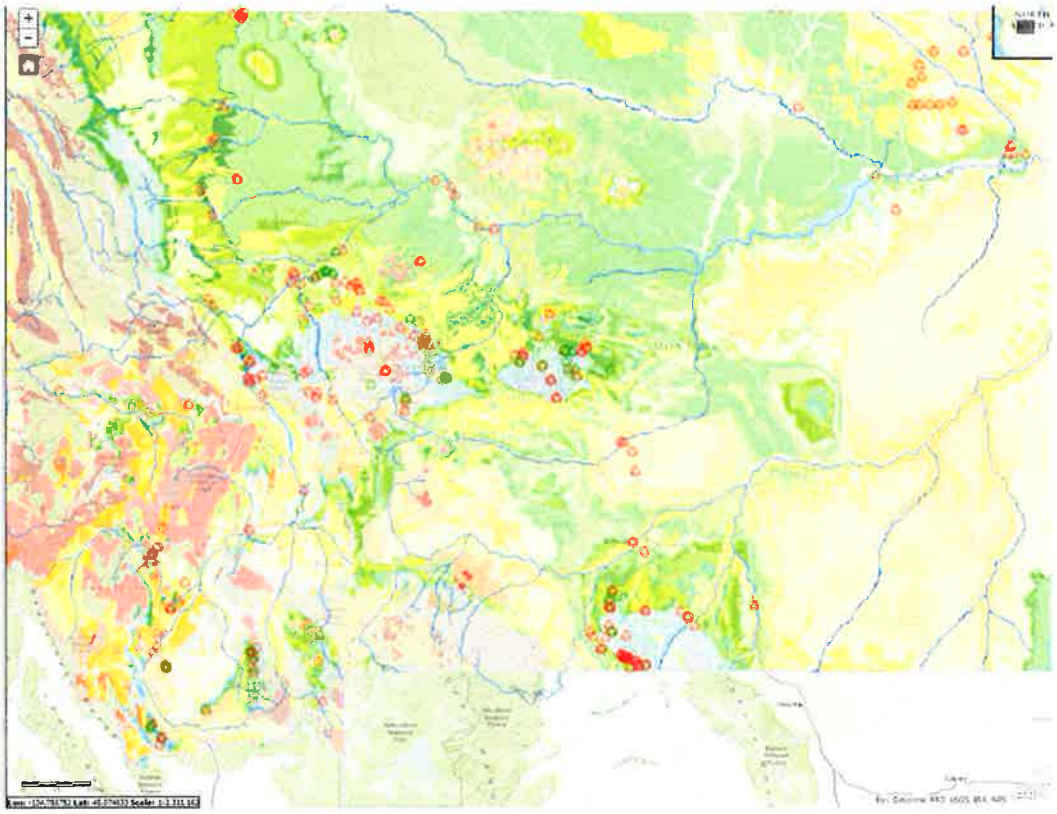

Figure 1 - All tested samples plotted on a geologic map of Montana. An interactive version of this map is available on the SNaP database (http://data.mbmg.mtech.edu/proppant/Data.asp).

Laboratory Methods

Background

Hydraulic fracture stimulation utilizes a slurry of water, proppant and small amounts of chemicals, pumped at high pressures and flow rates into oil or gas reservoir rock deep underground. The process creates narrow fractures in the rock, increasing the surface area available for production of hydrocarbons by many orders of magnitude. Fracture stimulation and advances in directional drilling have made production from "unconventional" shale and tight sand reservoirs economically viable. The result is that the United States, for the first time in more than 60 years, is poised to become a net exporter of oil and gas.

Proppant is a sand or sand-like material, either natural or man-made. It's purpose is to "prop" open the hydraulically-induced fractures, preventing them from closing. At the end of the stimulation process, the liquid portion of the slurry is produced back to the surface for safe disposal, while the proppant remains in the fractured reservoir rock. This propped fracture provides a high-conductivity pathway for the hydrocarbons to flow out of the reservoir rock, into the wellbore and ultimately to the surface.

Proppants left in the fractures experience long-term exposure to extreme conditions including high cyclic stress and high temperatures. For this reason, the material must exhibit high strength and low solubility. High purity silica sand is, by a wide margin, the most common and cost efficient solution. However, purity of the material is only part of the story. The goal is to create a proppant pack that is strong yet has internal voids sufficient to maintain high conductivity for the formation fluid. Because of this extreme environment, the material must have a low number of internal crystalline defects while also being well-rounded. Angular material exhibits both lower strength due to high point-loading and lower conductivity (lower production) due to decreased pore space between the proppant grains.

API RP 19C

The American Petroleum Institute (API) has adopted and published a set of standards designed to provide the oil and gas industry with the ability to predict the performance of material used as proppant. The API Recommended Practice 19C (RP19C) specifies a number of proppant characteristics that are used for this purpose. (These standards were also published by the ISO as 13503-2. With the newest version of these standards, the API has plans to drop the ISO co-listing.)

RP19C was written for the purpose of evaluating material that is being marketed as proppant. It provides procedures for sampling of bulk and bagged material, methods to assess silt- and clay-size particle content, acid solubility and loss of mass on ignition. These procedures are useful for, perhaps even critical to, post-manufacturing evaluation.

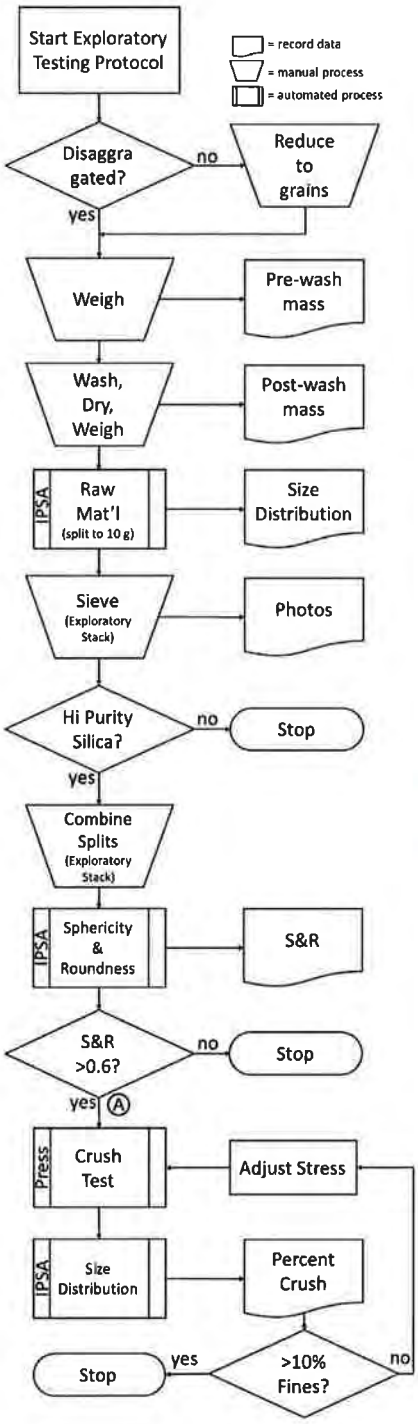

Figure 2 - Flow chart of the lab testing protocol

However, the RP19C methods were not intended to describe procedures that are most important to exploration-stage evaluation of native materials. For the purposes of this study, the API procedures were used as a basis to inform methods of evaluating raw material for use as a proppant. The methods chosen for this evaluation are shown graphically in Figure 2 and described below, in the sequence that they were applied in the lab.

Processing for Disaggregation

Most of the samples collected for this study exhibited some degree of cementation of the mineral grains. In order to be useful as a proppant, the material has to be disaggregated, separating the individual grains. In the lab, this process primarily involved hand crushing the material using a mortar and pestle. In some cases a jaw crusher was used to reduce the material to a manageable size which was then processed by hand.

Weigh, Wash, Dry and Weigh

The bulk disaggregated sample was weighed to provide a baseline. The sample was then washed with flow rate sufficient to float off material that was smaller than about 200 mesh (~75μm). Generally, water was used for this process. Where calcareous cement was present, a mild hydrochloric acid wash was used to assist in providing a clean sample.

The sample was then dried in a laboratory oven for a minimum of 24 hours at 95 °C and reweighed. The loss in mass from the bulk sample to the washed and dried end point allowed an estimation of the percentage of silt-size and smaller particles that were present in the bulk sample. This result may be useful in predicting requirements for a fugitive dust control program or estimating waste.

Bulk Particle Size and the "Exploratory Stack"

The RP19C defines a set of particle size distributions, or designations that are widely used in the oil and gas industry. Table 1 below, taken from the RP19C, indicates the sieve stack that is used for each of these size designations. The table also identifies the first and second primary sieves in each of these ranges using bold type face. The standards state that 90% or more of the material must be smaller than the first primary and bigger than the second. Put another way, no more than a total of 10% of the particles in a commercial 20/40 material may be larger than 20 mesh (the first primary) and smaller than the second primary, 40 mesh.

Table 1 - Testing Sieve Sizes[A]

	Testing Sieve Opening Sizes µm										
	3 350/ 1 700	2 360/ 1 180	1 700/ 1 000	1 700/ 850	1 180/ 850	1 180/ 600	850/ 425	600/ 300	425/ 250	425/ 212	212/ 106
	Typical proppant size designations										
	6/12	8/16	12/18	12/20	16/20	16/30	20/40	30/50	40/60	40/70	70/140
	Stack of ASTM Test Sieves[B] by Sieve Number										
Upper designating sieve in bold type	4	6	8	8	12	12	16	20	30	30	50
	6	**8**	**12**	**12**	**16**	**16**	**20**	**30**	**40**	**40**	**70**
	7	10	14	14	18	18	25	35	45	45	80
Lower designating sieve in bold type	8	12	16	16	20	20	30	40	50	50	100
	10	14	**18**	18	25	25	35	45	**60**	60	120
	12	**16**	20	20	30	30	40	**60**	70	**70**	**140**
	16	20	30	30	40	40	50	70	100	100	200
	pan	pan	pan	pan	pan	pan	pan	pan	pan	pan	pan

[A] USA Standard Sieve Series as defined in ASTM E11

[B] Testing sieves stacked in order from top to bottom, largest opening on top

Table 1 - Standard size designations as published in the API RP19C

A key measurement in this study was the fraction of the material that fell into each of the standard API size designations. This information is useful for predicting the fractions of useable product and the amount of waste that might be generated during processing of the material as it is prepared for sale. The size distribution information was used in this study to determine the dominant size fraction, which was then separated out as the target for the remaining tests.

The SNaP protocol was designed around an "exploratory sieve stack" consisting of eight ASTM sieves – numbers 16, 20, 30, 40, 50, 60, 70 and 140 plus a pan. This selection of sieves permits, in one operation, the separation of the material so that the dominant API size fraction can be assembled. The first column in Table 2 lists the API size designations. The second column indicates the sieves in the exploratory stack whose material is combined to create that API size fraction.

API Size	Sieve contents used
16/20	20
16/30	20, 30
20/40	30, 40
30/50	40, 50
40/60	50, 60
40/70	50, 60, 70
70/140	140

Table 2 - Exploratory Stack and API size designation

A Horiba CAMSIZER XT imaging particle size analyzer (IPSA) was used to provide a distribution of particle sizes present in the sample that is essentially continuous. The

CAMSIZER report was set up to list the fraction of material that would fall into each of the sieves in the exploratory stack. These results were then used to determine which of the API designations would contain the dominant fraction of the raw material, by simply adding together the fractions binned in each of exploratory sieves by the IPSA. Table 2 identifies the sieves that contain material that is combined to create each of the API size designations. Figure 3 is an example CAMSIZER report and the information it provides.

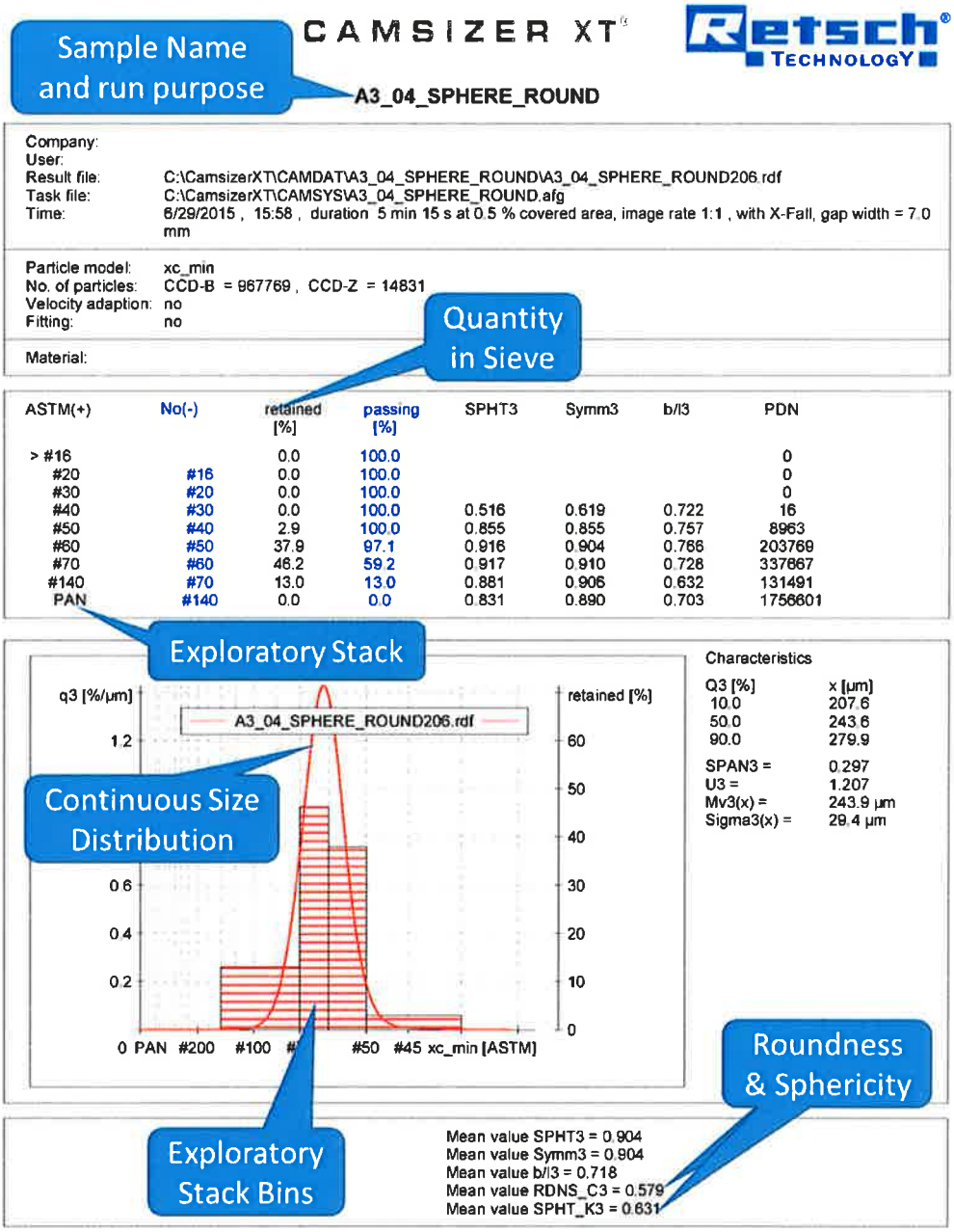

Figure 3 - CAMSIZER IPSA report. Annotations identify some of the important information from the report used in the evaluation of samples submitted for this project.

Testing was conducted only on the dominant size fraction as determined from the IPSA, based on the assumption that it is most likely to be of economic interest to developers.

Sieve to Separate by Size

In this step, the bulk sample was sieved using the exploratory stack on a Retsch AS-200 Control vibratory sieve shaker for 10 minutes at an amplitude of 0.99 mm The content of the individual sieves was used in several subsequent steps described below.

Micrographs and Minerology

For each of the sieve sizes in the exploratory stack, a sample was photographed using a Nikon SMZ800 microscope with a Canon EOS Rebel T1i camera. In many of the photographs, a 0.5 mm pencil lead was used to provide a size reference. These images are available via the web interface for the SNaP project.

The microscopic investigation was used to estimate the percentage of non-quartz particles in the sample and, qualitatively, the crystalline structure of the quartz present in the sample. The optical clarity of the individual grains is indicative of mono-crystalline quartz, which tends to have a greater resistance to crush. If a large fraction of the material appeared to consist of feldspars or other minerology, testing was stopped and the sample marked as not meeting API minimum standards.

Although there is no guidance from the RP19C on what fraction of non-silica material can be tolerated, the marketplace seems to have spoken on this issue. Our experience evaluating commercial proppants is that economically viable material generally consists of 90% or greater silica sand. Sands with 99% silica generally demand a premium price.

Microscopic investigation also assists in identifying grain clusters. Clusters are defined as individual grains that are mechanically attached (cemented) to one or more neighboring grains. High quality proppant contains very few clusters since the particles in clusters are generally weakly bound which creates issues both with resulting particle size and the fines released when the cement fails.

Combine Splits to Create Dominant API Size

The dominant API size fraction that was calculated in the step *Bulk Particle Size and Exploratory Stack*, was then used to identify those sieves whose contents must be combined to produce the dominant API size designation that is used for further testing in this protocol. For example, if the dominant size fraction is determined to be 40/70, at the end of the sieving process the material present in sieves numbered 50, 60, and 70 is combined to create the 40/70 fraction. The material retained in the sieves that was not part of this largest fraction is retained separately.

Sphericity and Roundness

Using a riffle sample splitter (Humboldt Micro Riffle Splitter Model #H-3971C) a 10 g aliquot was split out of the dominant API size fraction sub-sample for re-measurement with the IPSA.

There are two primary purposes for this measurement. The first is to confirm that the separation process produced a sample of the correct size. The RP19C criteria was used for this determination, which states that no more than 10% of the material may fall outside of the sizes specified by the first and second primary sieves.

The second purpose is to measure the sphericity and roundness of the largest size fraction. Both of these particle shape characteristics must be in excess of 0.6 to qualify for continued testing and this was used as a primary criterion for pass/fail. If either of these shape results did not meet this API threshold, the sample was identified as having failed and testing was stopped.

The API standard procedure for sphericity and roundness states that 20 particles are to be isolated from the bulk, and each assigned a value for roundness and sphericity of the particles by comparing them to the Krumbein/Sloss (API RP19C) chart (Figure 4). For this study, the calculations of sphericity and roundness provided by the IPSA were used, since this speeds the process and avoids the human bias associated with the API method.

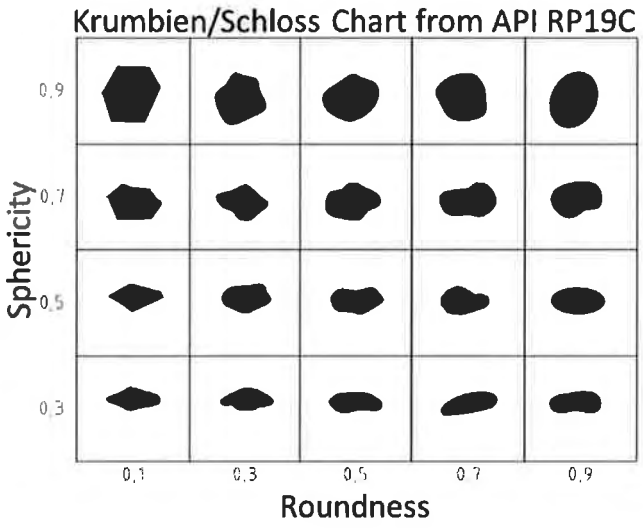

Figure 4 - Chart used for calculation of sphericity and roundness (API RP19C)

Crush Test

The "k factor" assigned to a proppant is defined in the RP19C protocol as the highest crush stress, in thousands of PSI, that produces a fraction of fines (by weight) of less than 10%. The percent of "fines," is defined as the fraction of the material that passes the second primary sieve. For the SNaP study, the post-crush IPSA run was used for the determination of the percent of fines.

If the selected size fraction was close to or exceeded the sphericity and roundness standards it was then split to produce an aliquot of 40 g, loaded into a crush cell (specified in RP19C) and exposed to a stress of 6,000 psi, per the methods of section 11

of RP19C. The entire 40 g sample was subsequently tested again with the IPSA to determine the change in the particle size distribution.

If the percent fines were greater than 10%, a fresh 40 g aliquot was split from the largest API size fraction and retested at 5,000 psi. This material was then tested for size distribution using the IPSA and the percent fines reported in the data base.

If the percent fines produced at 6,000 psi was less than the 10% threshold, the material was retested at 7,000 psi. (Figure 5)

The crush testing protocol that was developed for and used in the SNaP project is shown in summary form in the flow chart of Figure 2. Figure 5 provides specifics on the decision tree used for selecting crush stress values, as described above. This testing flow replaces the portion in Figure 2 at the point labeled Ⓐ. This portion of the flow chart was used in the SNaP project to provide additional information on the samples. In a program that uses only one crush test point to identify samples for future investigation, the more time-consuming method of Figure 5 may be vacated.

Industry data show that the smaller API size designations of a material consistently demonstrate greater strength. Since the majority of the material in this study tended toward the smaller sizes, for example 40/70 and 70/140, efficiency gains were realized by starting the crush tests at 6,000 psi.

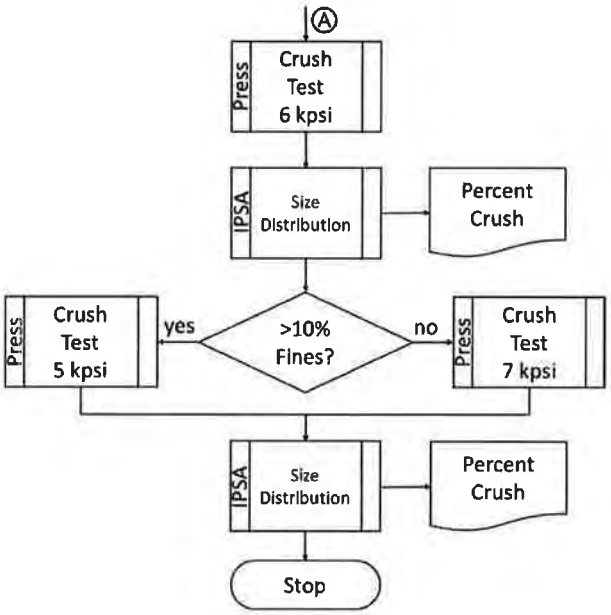

Figure 5 - Specific crush stress protocol used for SNaP

Field Sampling Approach

The primary criteria for determining which sandstones to sample were the abundance of quartz, presence of rounded and spherical sand grains and friability of the bulk rock. High-energy marine deposits and marginal marine sand-dune (eolian) deposits were considered the most likely possibilities for quartzose sandstone with well-rounded and spherical grains. The following sandstones were initially identified as sampling targets with the understanding that facies changes likely produced compositional and textural variability, and that friability may be highly variable: Virgelle Formation (Cretaceous), Fall River Formation (Cretaceous), Flood Member of Blackleaf Formation (Cretaceous), basal sandstone of the Thermopolis Formation (Flood Member and Fall River equivalent) (Cretaceous), Greybull Member of the Kootenai Formation (Cretaceous), Sunburst member of the Kootenai Formation (Cretaceous), Quadrant Formation (Pennsylvanian), Tensleep Formation (Pennsylvanian), and Tyler Formation (Pennsylvanian and Mississippian). In addition, the Goose Egg Formation (Permian) was considered a possible sampling target but was not sampled because of poor quality outcrops in its limited area of exposure in Montana.

Initially, the Flathead Formation (Cambrian) was not included as a sampling target because of tight cementation, but it was added with the discovery of friable Flathead in central Montana. Kibbey Formation (Mississippian) was not included because of its expected very fine grain size, but was added when outcrops were found with suitable grain size. The Shedhorn Formation (Permian) was also added based on field examination in the Gravelly and Madison Ranges. A report describing Quaternary eolian deposits (unconsolidated dune sand) suitable for proppant (Hickin, et al., 2010) prompted sampling of extensive Quaternary eolian deposits reworked from glacial deposits in northeastern Montana, where low transportation costs could make discovery of viable proppant material from this area economically attractive. An unrelated eolian deposit was also sampled along the Missouri River near Ulm in central Montana. All of the targeted sandstone and sand deposits produced at least one sample that met the API minimum criteria for proppant except three: Virgelle Formation, Flood Member of the Blackleaf Formation, and Fall River Formation.

Other sandstones contained large fractions of non-quartz clasts and therefore were not included in the initial sampling target list. Nevertheless some formations not initially identified – or those with less-than-ideal characteristics – were sampled and tested in order to provide more comprehensive results. The additional sandstones sampled include: Tongue River Member of the Fort Union Formation (Tertiary), Hell Creek Formation (Cretaceous), Fox Hills Formation (Cretaceous), Judith River Formation (Cretaceous), Eagle Formation (Cretaceous), Frontier Formation (Cretaceous), terrestrial sandstone from the Kootenai Formation (Cretaceous), Morrison Formation (Jurassic).

Efficacy of the sampling program benefitted from first-hand knowledge of the stratigraphic units and outcrop locations by MBMG geologists who had previously mapped much of the sample

area. If available, geologic field notes and large-scale geologic field maps prepared by the MBMG geologists were used to locate outcrops. U.S. Geological Survey geologic and topographic maps were also utilized.

Measured section descriptions from published sources, dissertations and theses were compiled and used to locate additional sandstone for sampling. Information from these historical sources along with researchers notes specific to the interests of the SNaP project are shown in Appendix E. These sources were also used to rule out proppant potential of sandstones in certain areas. For example, the poorly accessible Flathead Formation in the Bighorn Mountains was described as tightly cemented, and therefore was not sampled.

Data collected in the field included the latitude, longitude and elevation as measured with a handheld GPS. Samplers were requested to provide pictures of the sampling location and outcrop. Approximately 0.5 kg of material was collected at each point and placed into a plastic or cloth sack with tight weave to reduce the loss of fines during shipment back to the lab at Montana Tech. In some cases, a field sampling form was used to prompt for the information required (Appendix D.) Some microscopic images were acquired in the MBMG Billings office using an OMANO OM99 microscope with an Optix Summit Series Camera.

Most samples were collected along roads, but some involved walking less than a half mile in order to access the sandstone. Grab samples were taken of sand/sandstone that, based on field examination, appeared likely to meet the proppant criteria. In some cases more than one sample was taken from different stratigraphic horizons at the same sample location. The Quadrant and Flathead Formations were sampled even where they appeared tightly cemented to help delineate the area where friable sandstone is present in those formations.

Results

Below are brief descriptions of field observations and summaries of the lab test results.

Formations with Potential as a Proppant Source

Eolian (Quaternary)

Twenty eight samples were collected from Quaternary eolian deposits reworked from glacial sediment in Valley, Roosevelt, Sheridan, and Daniels Counties in northeastern Montana (Figure 6A). Another eolian deposit was sampled (GFS 22, Figure 6B) in Cascade County just south of Ulm along the west bank of the Missouri River.

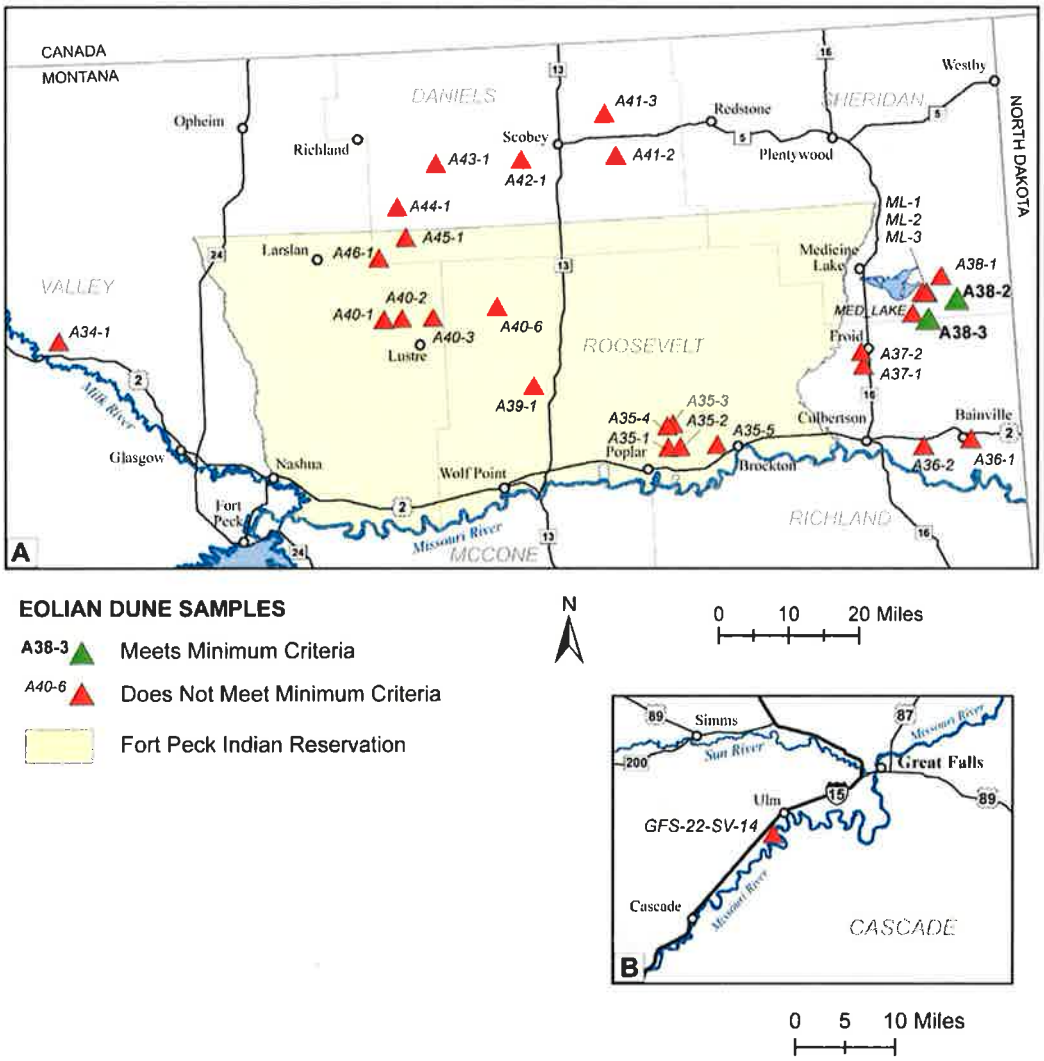

Figure 6 - Sample locations from eolian deposits (sand dunes) reworked from glacial sediment. Two samples in the southeastern part of the eolian deposit exposures, identified by green icons and bold font in figure 6A, passed the minimum requirements for proppant material. Figure 6B shows the location of another eaolian deposit sample.

Although many of the samples did not pass the lab tests because of an insufficient percentage of quartz grains, two samples in the southeast part of the sampling area passed all tests except the highest crush test. Samples A38-2 and A38-3 both have mesh size of 70/140 and passed the 5,000 psi crush tests at 9.3% and 7.7% fines produced, respectively. Samples A38-2 and A38-3 are located in the southeastern part of Sheridan County.

Figure 7 compares the quality of the sand from Sample A38-3 (passed testing) with that of Sample A43-1 (failed testing.) The clarity and relative abundance of quartz grains is significantly higher for sample A38-3.

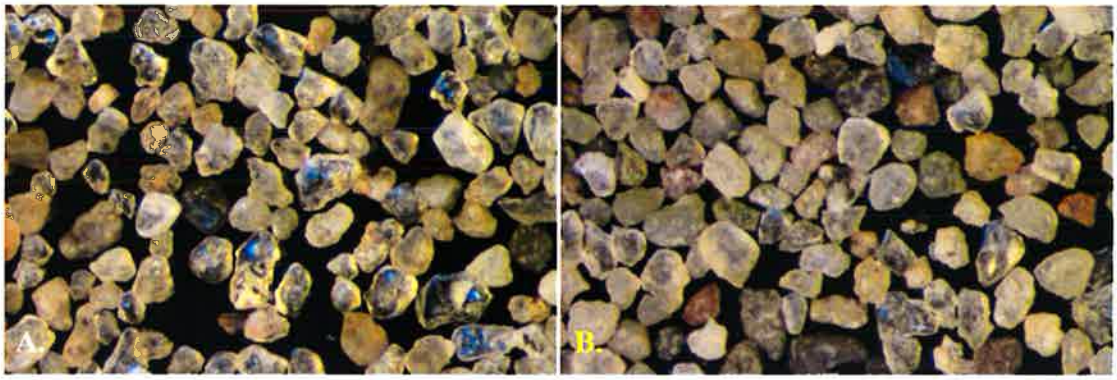

Figure 7 - Eolian sand (Quaternary) reworked from glacial deposits. A. Microscopic view of Sample A38-3 at the 70/140 mesh size. B. Microscopic view of Sample A43-1 at the 70/140 mesh size.

GFS-22 (sample location in Figure 6) has an API sieve size of 40/70, however, upon inspection with an optical microscope it appears that the sample contains significant amounts of non-quartzose material and is therefore less desirable for use as proppant. The sphericity and roundness of this sample were 0.573 and 0.525 which also failed to meet the minimum requirements for further testing. Figure 8 shows an example of the 70 mesh material from sample GFS 22 with several lithic clasts identified.

Figure 8 - Eolian glacial deposit near Ulm, MT (GFS-22). 70 mesh shown under a microscope with a 0.5mm pencil lead for scale. The red circles identify some of the lithic clasts that hinder the use of this eolian sand as proppant.

Table 3 provides a summary of the results for those eolian sand samples that met the minimum API criteria for proppant. As stated above, in order to meet the API specifications a sample must consist mainly of quartz sand, have sphericity and roundness values exceeding 0.6 (or nearly so) and produce 10% or less fines at a minimum crush stress of 5,000 psi.

Sample Name	Latitude	Longitude	County	Mesh Size	Sphericity	Roundness	% Fines			
							5,000 psi	6,000 psi	7,000 psi	8,000 psi
A38-2	48.42565	-104.21662	SHERIDAN	70/140	0.622	0.659	9.3	10.1		
A38-3	48.38948	-104.30852	SHERIDAN	70/140	0.618	0.659	7.7	12.0		

Table 3 - Summary of the results from the samples which met the minimum criteria for proppant material from the eolian (Quaternary) deposits. All of the samples in this table had adequate sphericity and roundness values as observed using the imaging particle size analyzer (IPSA.) Green cells indicate that the percentage of fines produced at a particular crush stress was acceptable for proppant. Red cells indicate that the percentage of fines produced at a particular crush stress exceeded the 10% threshold in RP19C.

Thermopolis Formation, basal sandstone (Cretaceous)

A total of nine samples were collected from the basal sandstone of the Thermopolis Formation, three samples passed the minimum API standards requirements for proppant. Figure 9 shows the sample locations in Madison, Meagher, and Gallatin Counties.

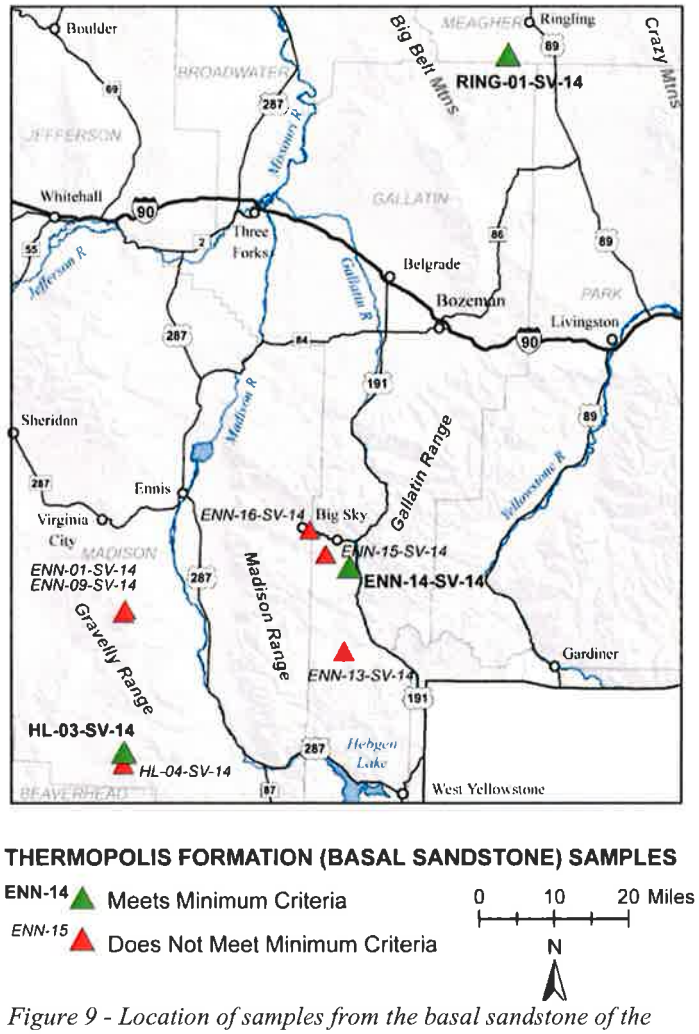

Figure 9 - Location of samples from the basal sandstone of the Thermopolis Formation

Of the nine samples collected from the Thermopolis Formation, all but ENN-16 had the majority of sand grains collect in the 140 sieve size. ENN-16 had majority of grains collect in the 16/30 API mesh size however these grains showed extensive clustering, indicating inadequate disaggregation.

The samples that met minimum API standards for proppant material were HL-03, ENN-14, and RING-01. HL-03 and RING-01 passed crush testing at 6,000 psi with only 4.5% and 7.4% fines produced and then failed crush tests at 7,000 psi (10.6% and 10.7% respectively). ENN-14 failed the crush test at 6,000 psi (12.5% fines produced) and then passed the crush test at 5,000 psi with 8.8% fines produced.

A comparison between adjacent samples from the basal sandstone of the Thermopolis Formation is presented in Figure 10. Grains from sample ENN-15 (Figure 10B) exhibit higher sphericity and roundness than sample ENN-14 (Figure 10A). However, ENN-15 failed crush tests and ENN-14 passed. Comparison between samples HL-03 and HL-04 (Figure 10C, D) shows a difference in the roundness of sand grains. Sample HL-03 passed the crush test at 5,000 psi (4.5% fines) but failed at 6,000 psi (10.6% fines.) These results are summarized in Table 4.

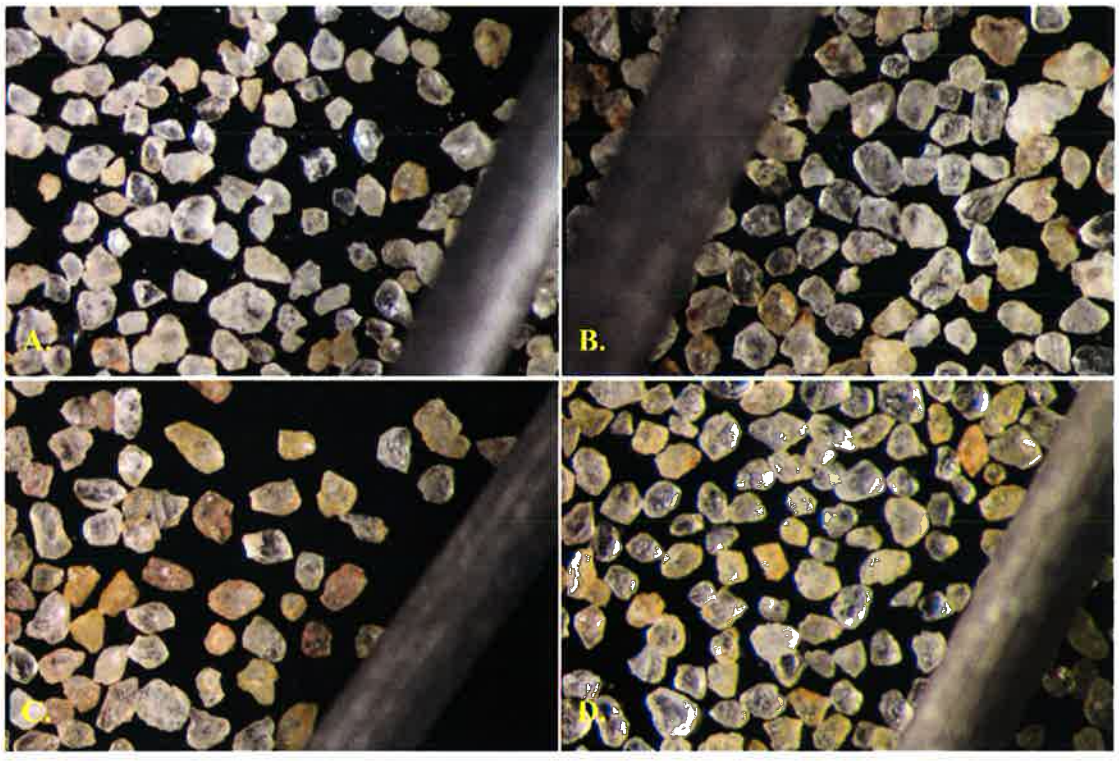

Figure 10 - Comparison between the grains retained in the 140 sieve size from adjacent samples ENN-14 and ENN-15, (A and B) and HL-03 and HL-04, (C and D). Samples shown in A and C passed crush tests, the sample shown in B failed crush tests. The sample shown in D did not exhibit sufficient roundness (0.424) for further testing. A 0.5mm piece of lead is used for scale.

Sample Name	Latitude	Longitude	County	Mesh Size	Sphericity	Roundness	% Fines			
							5,000 psi	6,000 psi	7,000 psi	8,000 psi
ENN-14-SV-14	45.217170	-111.268165	GALLATIN	70/140	0.619	0.553	8.8	12.5		
HL-03-SV-14	44.850346	-111.869837	MADISON	70/140	0.655	0.655		4.5	10.6	
RING-01-SV-14	46.209226	-110.865616	MEAGHER	70/140	0.651	0.620		7.4	10.7	

Table 4 - Summary of the results from the samples which met the minimum criteria for proppant material from the Thermopolis Formation.

Except for the samples identified above, all other samples failed to meet minimum criteria for proppant due to insufficient roundness. ENN-15 passed all preliminary tests but failed the crush tests at 6,000 psi and 5,000 psi with 15.9% and 11.4% fines produced respectively. Overall, test results reveal that the basal sandstone in the Thermopolis Formation produces marginally viable proppant material.

Kootenai Formation (Cretaceous)

The Kootenai Formation is a non-marine deposit throughout Montana with two marginal marine exceptions, the Sunburst member in the middle Kootenai Formation near Great Falls, and the Greybull Member in the uppermost part of the Kootenai Formation in south-central Montana. The non-marine sandstones were initially not sampling targets because they typically contain abundant chert and lithic clasts, whereas the Sunburst and Greybull Members were targeted because those sandstones are known to be highly quartzose.

Kootenai Formation: Greybull Member

Ten samples were taken from the Greybull Member of the Kootenai Formation which is only exposed in the Pryor Mountains in Yellowstone and Carbon Counties. The sample locations are shown in Figure 11. Samples meeting the minimum API criteria are shown in Table 5.

Samples A03-2 and A03-3 passed the proppant test criteria including crush testing at 5,000 psi producing 5.0% and 6.7% fines respectively. Each of these samples had 40/70 first and second primaries and exhibited strong sphericity and roundness. Sample A31-1 also passed the proppant criteria with 8.6% fines produced after the 6,000 psi crush test. The remaining samples failed the crush test procedure at 5,000 psi. Sample A31-1 was taken from above a channel and sample A31-2 was taken 20' below the channel at the same latitude and longitude; the sand grains from the lower sample exhibited much lower roundness than those of the sample taken from above the channel.

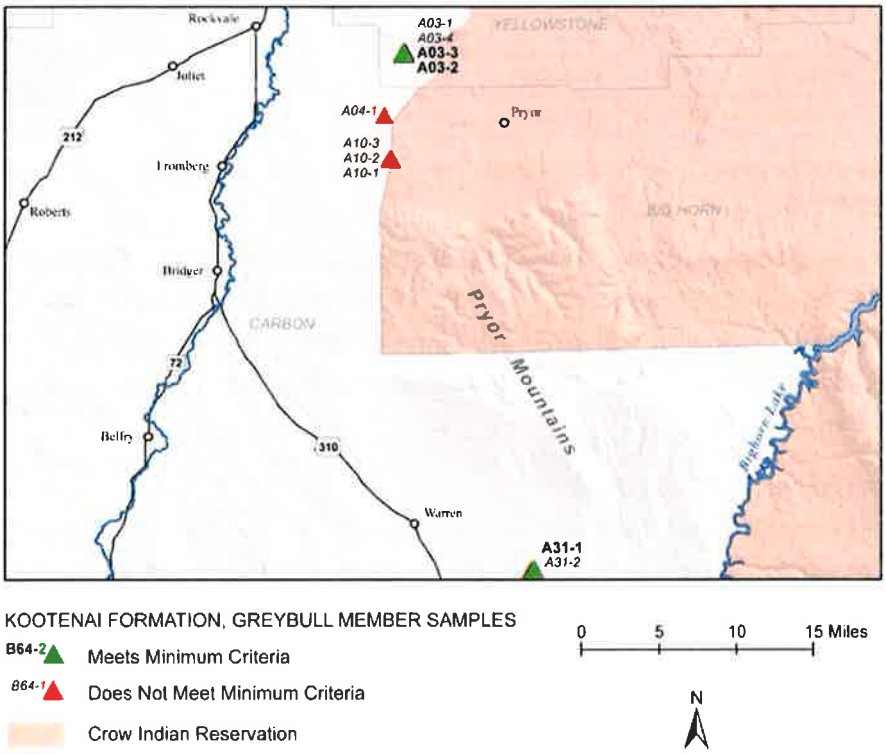

Figure 11 - Sample locations in the Greybull Member of the Kootenai Formation

Sample Name	Latitude	Longitude	County	Mesh Size	Sphericity	Roundness	% Fines			
							5,000 psi	6,000 psi	7,000 psi	8,000 psi
A03-2	45.4962264	-108.6652333	CARBON	40/60	0.626	0.683	5.0	20.2		
A03-3	45.49671267	-108.6645065	CARBON	40/70	0.630	0.633	6.7	11.1		
A31-1	45.01635	-108.50602	CARBON	40/70	0.630	0.604		8.5	11.7	

Table 5 - Summary of the results for samples meeting minimum criteria from the Kootenai Formation, Greybull Member

Pictures of three mesh size fractions, 30-/40+, 40-/50+ and 60-/70+ from sample A03-2 (Figure 12), reveal an abrupt cutoff in particle size at the 40-/50+ boundary, since the material taken from the 40 mesh sieve shows large numbers of clusters. There are no obvious clusters in either the 50 or 70 mesh fractions. Because the material collected in the 40 mesh and larger sieves consist primarily of clusters, care should be exercised in interpreting the CAMSIZER results on samples that show a large particle size.

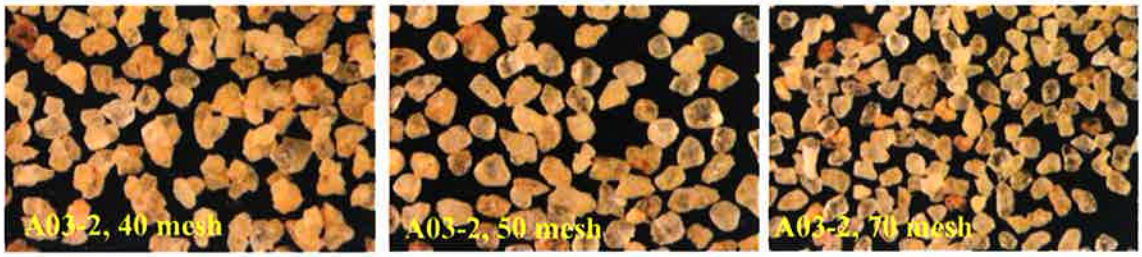

Figure 12 - Three size fractions from the A03-2 sample, Greybull Member of the Kootenai Formation

Kootenai Formation: Sunburst Member

Thirty samples from the Sunburst Member of the Kootenai Formation near Great Falls, Montana are plotted on the map of Figure 13.

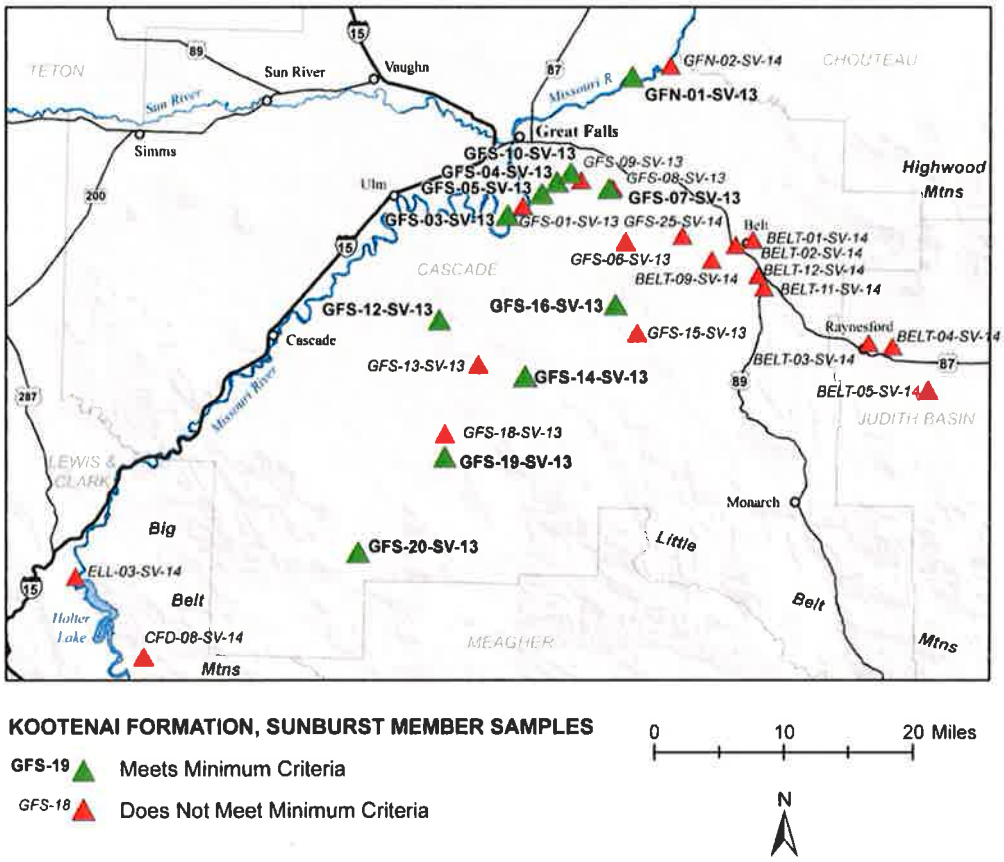

Figure 13 - Locations of samples collected from the Sunburst member of the Kootenai Formation.

Of those 30 samples, 11 met the minimum API criteria for proppant material. All but one of the passing samples (GFS-07) had API sizes of 70/140. GFS-07 had an API sieve size of 40/70 and passed crush tests at 6,000 psi and 7,000 psi with 6.75% and 8.3% fines produced respectively, making this a stand-out sample in this study. Sample GFS-04 (Figure 14) produced the lowest percentage of fines (8.8%) after crush testing at 7,000 psi and is an example of potential proppant material.

Table 6 provides a summary of the Sunburst Member samples that passed the minimum criteria.

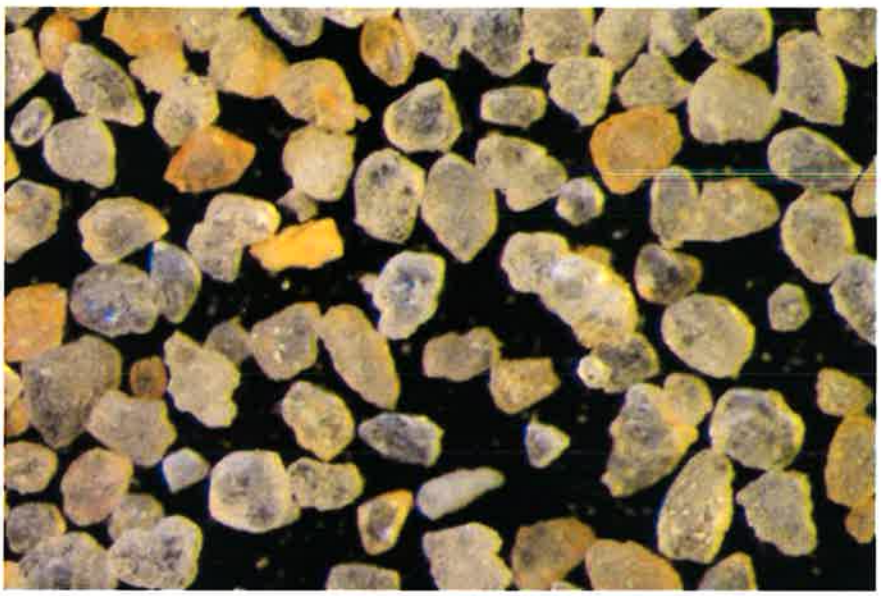

Figure 14 - Sample GFS-04 grains at 140 mesh size. This sample passed all preliminary tests and crush tests at 6,000 and 7,000 psi. Some quartz grains exhibit minor iron staining.

None of the samples collected near Belt, Montana (east-southeast of Great Falls) met the minimum proppant criteria.

The Sunburst member of the Kootenai Formation in areas near Great Falls, Montana contains material that may have economic value as proppant. Those samples from the Kootenai Formation that exceeded the API minimums are listed in Table 6.

Sample Name	Latitude	Longitude	County	Mesh Size	Sphericity	Roundness	% Fines			
							5,000 psi	6,000 psi	7,000 psi	8,000 psi
GFN-01-SV-13	47.56971	-111.12045	CASCADE	70/140	0.653	0.657		9.3	12.9	
GFS-03-SV-13	47.41254	-111.31773	CASCADE	70/140	0.696	0.680		9.25	12.75	
GFS-04-SV-13	47.45054	-111.23826	CASCADE	70/140	0.644	0.641		6.5	8.75	10.5
GFS-05-SV-13	47.43757	-111.26246	CASCADE	70/140	0.638	0.651			9.9	12.5
GFS-07-SV-13	47.44667	-111.15008	CASCADE	40/70	0.678	0.571		6.75	8.25	11.43
GFS-10-SV-13	47.46126	-111.21637	CASCADE	70/140	0.640	0.548		8.75	11.9	
GFS-12-SV-13	47.29385	-111.42662	CASCADE	70/140	0.659	0.675	6.25	11.25		
GFS-14-SV-13	47.23266	-111.28306	CASCADE	70/140	0.652	0.683		7.5	10.25	11.75
GFS-16-SV-13	47.31526	-111.13943	CASCADE	70/140	0.655	0.681		7.55	9.92	12.91
GFS-19-SV-13	47.14088	-111.41181	CASCADE	70/140	0.667	0.674		8.0	10.25	16.66
GFS-20-SV-13	47.03229	-111.55112	CASCADE	70/140	0.662	0.651		5.78	10.76	

Table 6 - Summary of the results from the samples which met the minimum criteria for proppant material from the Kootenai Formation, Sunburst Member. Nearly all of the samples in this table met the sphericity and roundness criteria of 0.6.

Kootenai Formation: Additional Samples

Eleven samples were collected from the Kootenai Formation from sandstone not associated with either the Greybull or Sunburst members. Eight of the samples were tested and their locations are shown in **Error! Reference source not found.**. Of these samples only two passed, C81-01 and A33-01. A33-01 passed crush tests at 6,000 and 7,000 psi (4.0% and 7.7% fines produced respectively) and then failed crush testing at 8,000 psi with 12% fines produced. This sample was located on the east side of the Big Snowy Mountains and further investigation of this area would be necessary to conclude that there is potential proppant from this part of the Kootenai Formation. Sample C81-01 passed crush testing at 5,000 psi (7.2% fines produced). The Kootenai Formation exposures near the Little Belt Mountains in the area where C81-01 was sampled are limited, resulting in the collection of only a few samples. Sample B61-02 contained a large fraction of non-quartz lithic components. For this reason, samples B61-01, B61-03 and B61-04, that were collected from the same location as B61-02 were not tested. These samples were collected from bedding about 2" in thickness.

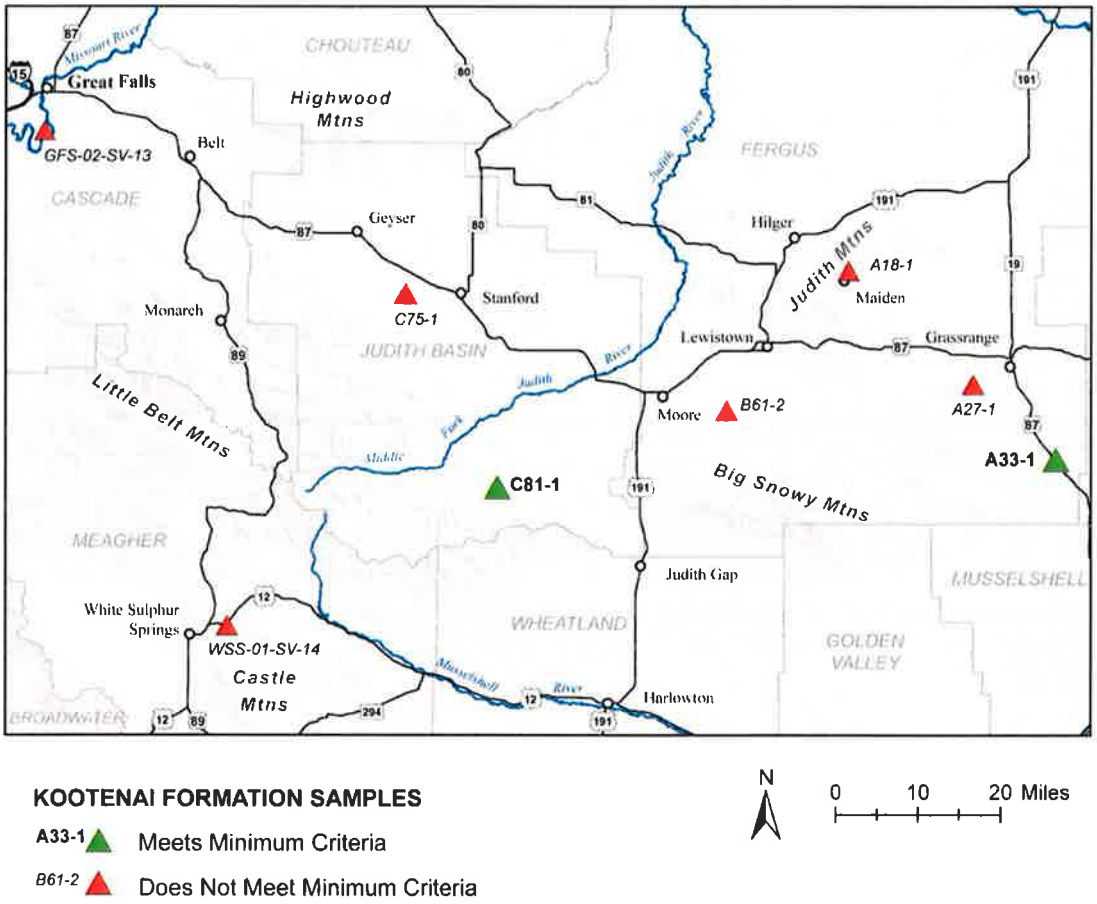

Figure 15 - Samples collected from the Kootenai Formation other than the Greybull or Sunburst members.

Table 7 provides a summary of the results for the two samples from Kootenai Formation that passed the minimum testing criteria.

Sample Name	Latitude	Longitude	County	Mesh Size	Sphericity	Roundness	% Fines			
							5,000 psi	6,000 psi	7,000 psi	8,000 psi
A33-1	46.86162	-108.68897	FERGUS	70/140	0.642	0.611		4.0	7.7	11.7
C81-1	46.81455	-110.12078	JUDITH BASIN	40/70	0.670	0.619	7.2			

Table 7 - Summary of the results from the samples which met the minimum criteria for proppant material from the Kootenai Formation. Both samples had adequate sphericity and roundness values.

Shedhorn Formation (Permian)

Five samples were collected from the Shedhorn Formation in the Gravelly Range in Madison County, Montana (Figure 16).

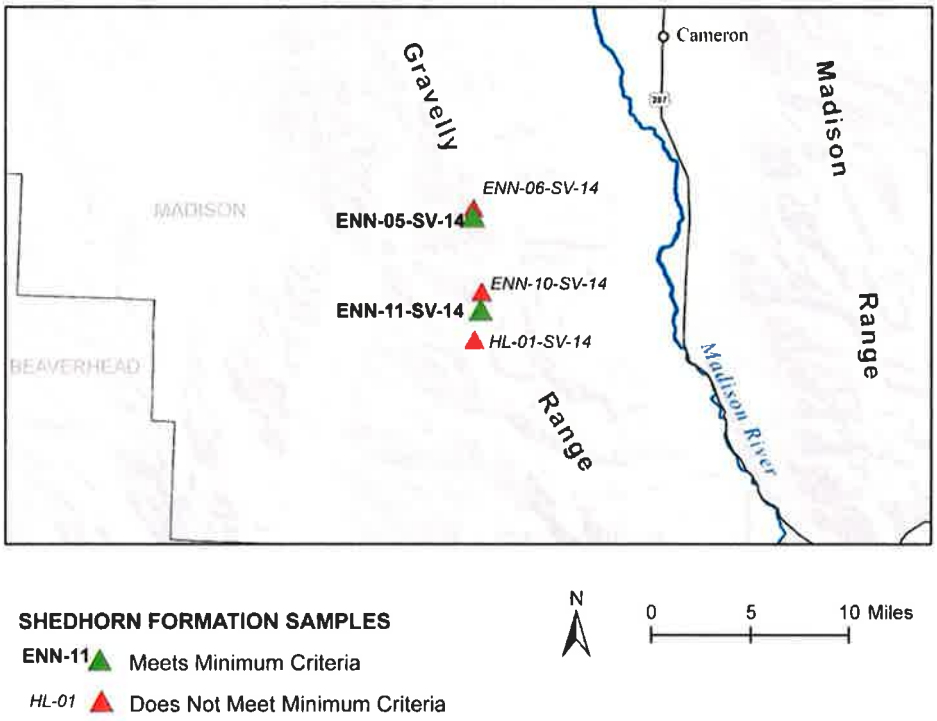

Figure 16 - Samples collected in Madison County from the Shedhorn Formation.

Samples ENN-11 and ENN-05 met the minimum standards for proppant material. ENN-11 produced 6.9% fines after 5,000 psi crush testing and 10.5% after crush testing at 6,000 psi. ENN-05 passed the crush test at 6,000 psi with 10.0% fines produced and then failed crush testing at 7,000 psi with 13% fines produced (Table 8). Testing was not completed on the remaining samples from this formation due to the presence of significant amounts of clusters at the dominant API size designation.

Table 8 provides a summary of the two samples from the Shedhorn formation that showed some promise.

Sample Name	Latitude	Longitude	County	Mesh Size	Sphericity	Roundness	% Fines			
							5,000 psi	6,000 psi	7,000 psi	8,000 psi
ENN-05-SV-14	45.068686	-111.867689	MADISON	70/140	0.648	0.627		10.0	13.2	
ENN-11-SV-14	45.001246	-111.856647	MADISON	70/140	0.657	0.642	6.9	10.5		

Table 8 - Summary of the results from the samples which met the minimum criteria for proppant material from the Shedhorn Formation.

Quadrant Formation (Pennsylvanian)

Fifty-two samples were collected from the Quadrant Formation in central and southwest Montana (Figures 17 and 18). Seventeen of those met the minimum criteria for proppant material (Table 3.)

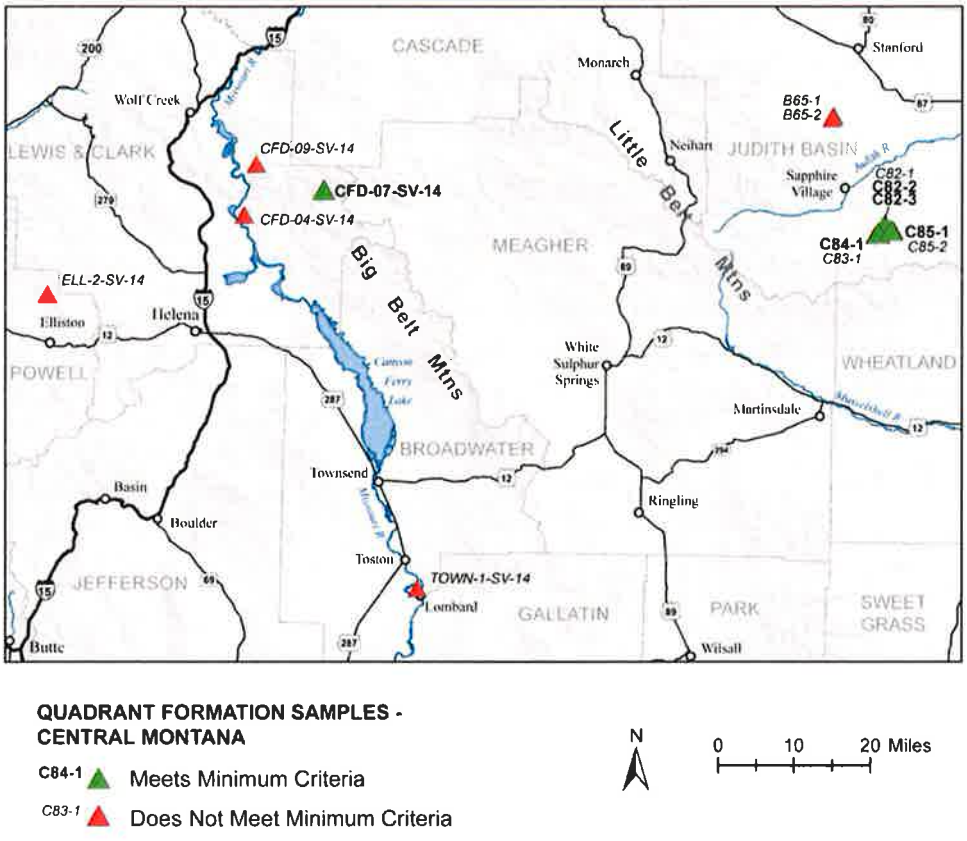

Figure 17 - Samples collected from the Quadrant Formation in central Montana.

In the central part of the state, a total of five samples of the Quadrant from Lewis and Clark and Judith Basin counties passed the minimum criteria. Four samples (C82-2, C82-3, C84-1, and C85-1) passing crush tests were located in close proximity to each other on the eastern flank of the Little Belt Mountains (Figure 17). Samples C82-1 through C85-3 were sampled from the same outcrop at different elevations. Sample C82-1 failed crush tests but C82-2 and C82-3, from higher in the section, passed (Table 3). Based on the small number of samples, the material appears to be better toward the top of the formation at this location. Also in Judith Basin County, samples C84-1 and C85-1 both passed crush testing at 5,000 psi with 6.0 and 6.4 percent fines produced, respectively.

The sample CFD-07 in the Big Belt Mountains had a dominant API designation of 70/140, but fell just below the 10% threshold at 5,000 psi. At 6,000 psi the sample produced 14% fines, a lackluster performance for this small grain size material.

In the southwestern Montana, 38 samples were collected from the Quadrant Formation (Figure 18). Of these, 12 passed the minimum criteria for proppant.

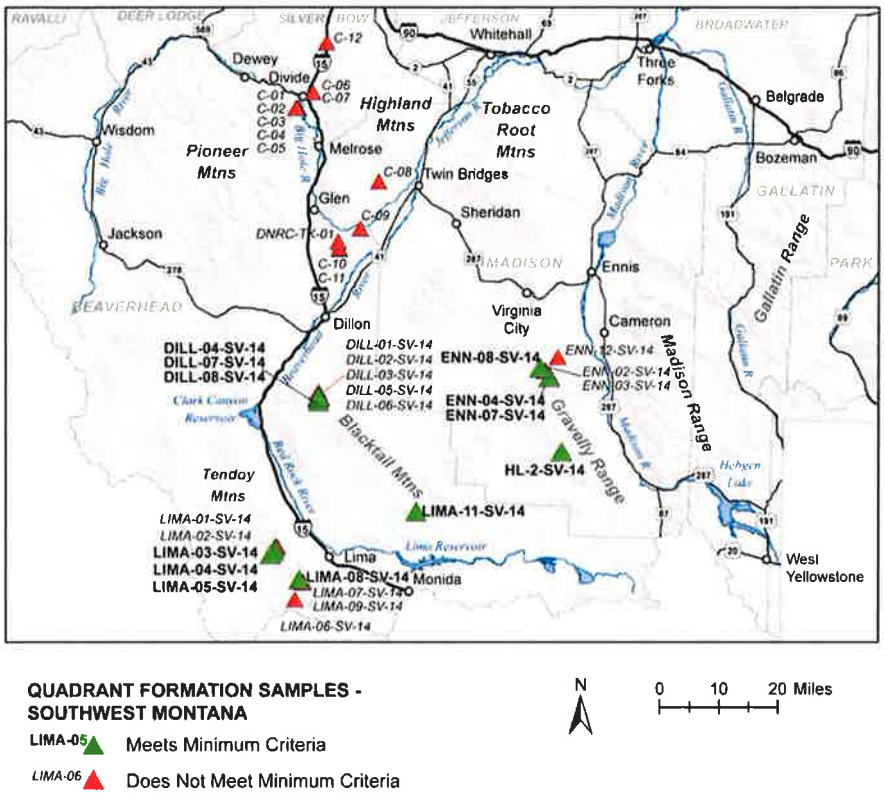

Figure 18 - Quadrant Formation samples in southwestern Montana.

Table 9 summarizes the data for the 17 samples from the Quadrant Formation that surpassed the minimum API requirements.

Sample Name	Latitude	Latitude	County	Mesh Size	Sphericity	Roundness	% Fines			
							5,000 psi	6,000 psi	7,000 psi	8,000 psi
C82-2	46.82038	-110.1416	JUDITH BASIN	70/140	0.639	0.664		6.4	12.3	
C82-3	46.82038	-110.1416	JUDITH BASIN	70/140	0.628	0.649		8.8		
C84-1	46.80445	-110.15912	JUDITH BASIN	70/140	0.626	0.656	6.0			
C85-1	46.81047	-110.12305	JUDITH BASIN	70/140	0.644	0.682	6.4			
CFD-07-SV-14	46.86801	-111.695397	LEWIS AND CLARK	70/140	0.669	0.628	10.0	14.0		
DILL-03-SV-14	45.023159	-112.653849	MADISON	70/140	0.659	0.682	5.7	10.4		
DILL-07-SV-14	45.013463	-112.651204	MADISON	70/140	0.639	0.654		5.5	6.6	12.2
DILL-08-SV-14	45.024181	-112.649685	MADISON	70/140	0.657	0.658		10.0	11.2	
ENN-04-SV-14	45.091799	-111.86168	MADISON	70/140	0.653	0.627		8.1	12.4	
ENN-07-SV-14	45.090977	-111.862455	MADISON	70/140	0.646	0.644		8.7		
ENN-08-SV-14	45.114751	-111.893332	MADISON	70/140	0.659	0.605		8.1	10.6	
HL-02-SV-14	44.911729	-111.813007	MADISON	70/140	0.641	0.613	7.9	10.2		
LIMA-03-SV-14	44.653248	-112.779823	BEAVERHEAD	70/140	0.656	0.614	8.3	13.0		
LIMA-04-SV-14	44.645591	-112.782381	BEAVERHEAD	70/140	0.657	0.655		7.9	8.8	12.5
LIMA-05-SV-14	44.637965	-112.791862	BEAVERHEAD	70/140	0.649	0.622		8.6	11.2	
LIMA-08-SV-14	44.579585	-112.692466	BEAVERHEAD	70/140	0.655	0.658	8.9	11.7		
LIMA-11-SV-14	44.756506	-112.30003	BEAVERHEAD	70/140	0.657	0.665	6.5	12.0		

Table 9 - Summary of the results from the samples which met the minimum criteria for proppant material from the Quadrant Formation. All of the samples in this table had adequate sphericity and roundness values.

All of the samples that showed promising results for proppant material had API sieve sizes of 70/140. Therefore the vast majority of potential proppant material from the Quadrant Formation seems to be composed of fine to very fine sand grains according to the Wentworth standard sizing chart (Appendix B). The most promising material from the Quadrant is located near Lima and Dillon. Two samples passed crush testing at crush strength of 7,000 psi; samples DILL-07 and LIMA-04. Grains collected in the 140 sieve for these samples are shown in Figure 19.

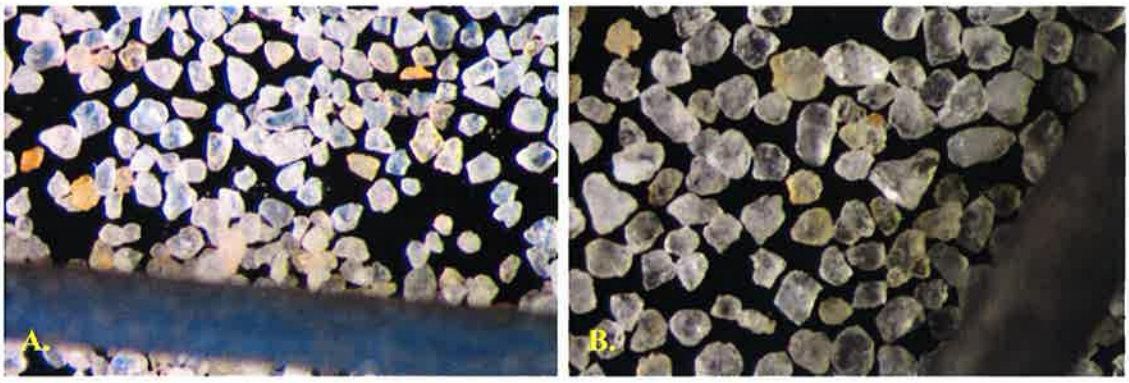

Figure 19 - A] Grains from sample DILL-07 at the 140 sieve size. B] Grains from sample LIMA-04 at the 140 sieve size. Both Quadrant samples have good sphericity and roundness as well as clarity and quartz content.

Tensleep Formation (Pennsylvanian)

Thirty-eight samples were collected from the Tensleep Formation in Bighorn and Carbon Counties, Montana (Figure 20). Four samples met the minimum criteria for proppant material and are displayed with green icons and bold font. Samples A07-1 through A07-4 were sampled at the same location, going upsection in 10' increments. A07-1 was collected from a very fine grained sandstone near the base of the outcrop in what appeared to be a dune deposit. The uppermost sample (A07-4) was collected from a massive sandstone that overlies the dune sandstones.

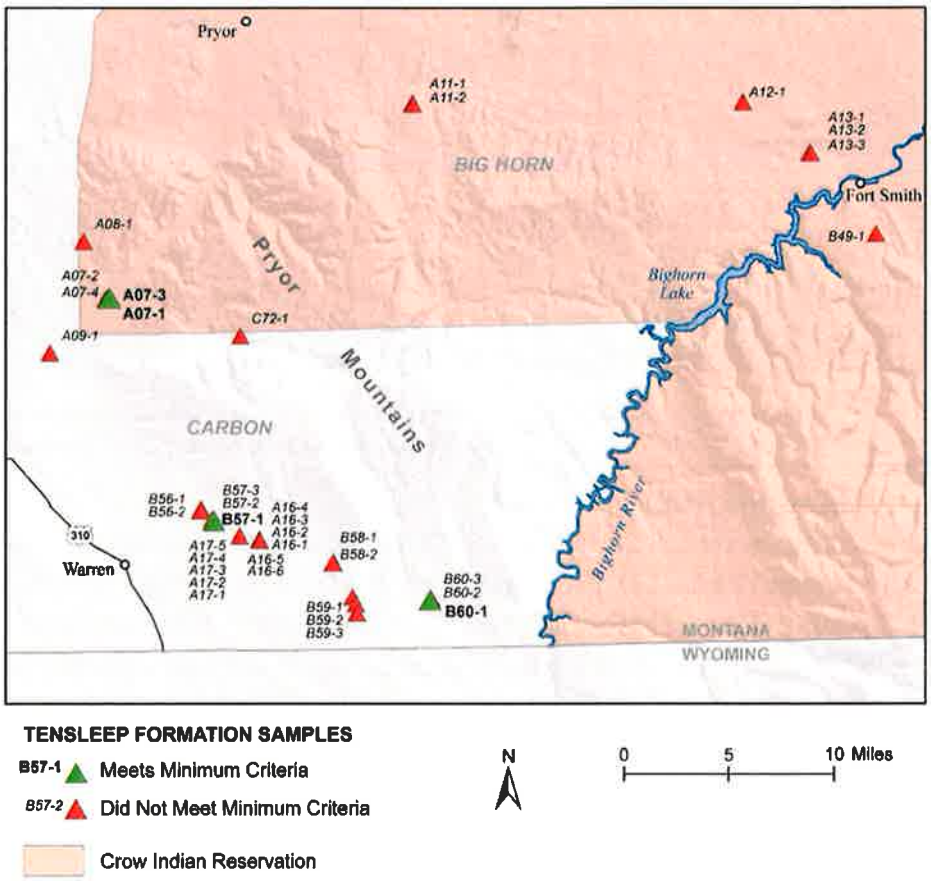

Figure 20 - Sample locations in the Tensleep Formation

All of the samples from this formation showed good sphericity and roundness but also exhibited very fine grain size. Many samples showed clusters even at a mesh size of 140. Samples A07-1 and A07-3 met the minimum criteria for proppant material and passed crush tests at 6,000 psi (7.8% fines produced) and 5,000 psi (9.61% fines produced) respectively. These two samples were collected from dune sands, whereas "failed" samples A07-2 and A07-4 were collected from intervening beds of marine sandstones

Figure 21 - Tensleep Formation: A] Lower dune sandstone, very fine grained where sample A07-1 was collected. B] Outcrop of reworked marine sandstone where sample A07-2 was collected. C] Contact between cross-bedded dune sandstone (A07-3 sample) and marine sandstone (A07-4 sample).

B57-1 was the only sample from the Tensleep Formation that passed crush testing at 6,000 and 7,000 psi (6.0% and 7.7% fines produced respectively.) Sample B60-1 passed 5,000 psi crush testing with 8.8% fines produced. Samples B57-1 and B60-1 were collected along the southwest side of the Pryor Mountains and were composed of very fine grained, white, friable sandstone with potential for use as proppant if small particle size is acceptable.

Figure 22A shows the sampled outcrop and Figure 22B shows quartz grains from sample B57-1 from the 140 sieve size under a microscope. These quartz grains are rounded, semi-spherical and show high clarity.

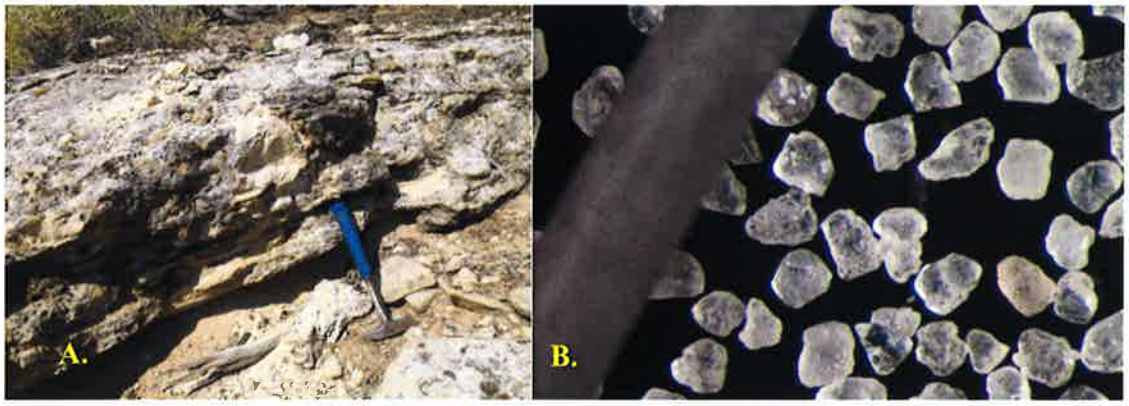

Figure 22 - A] Outcrop of friable, white, dune sand where sample B57-1 was collected. B] Microscope view of sample B57-1 at the 140 sieve size with a piece of 0.5mm lead for scale. Tensleep Formation.

The upper part of the Tensleep Formation is composed of alternating cycles of eolian dune sandstone and calcareous shallow marine sandstone (Lopez et al., 2007). Although none of the marine sandstones passed the minimum criteria, eolian dune sands may have potential as viable proppant material. The interbedding of dune sandstone with calcareous marine sandstones could make quarrying a challenge. Therefore, a more thorough investigation of dune sandstone within

the upper Tensleep Formation may be important. A summary of the samples that exceeded the minimum API specification is shown in Table 10.

Sample Name	Latitude	Longitude	County	Mesh Size	Sphericity	Roundness	% Fines			
							5,000 psi	6,000 psi	7,000 psi	8,000 psi
A07-1	45.24218575	-108.6739454	CARBON	70/140	0.633	0.641		7.8	12.3	
A07-3	45.24236238	-108.6739088	CARBON	70/140	0.635	0.602	9.61	12.17	13.8	
B57-1	45.09027	-108.57377	CARBON	70/140	0.635	0.654	6.0	7.7	12.8	
B60-1	45.03252	-108.36217	CARBON	70/140	0.643	0.648	8.8	14.6		

Table 10 - Summary of the results for samples which met the minimum criteria for proppant material from the Tensleep Formation.

Tyler Formation (Pennsylvanian and Mississippian)

A total of thirty-four samples were collected from the Tyler Formation in Fergus and Judith Basin Counties, Montana. Sample locations are shown in Figure 23.

Twenty-one samples met the minimum criteria for proppant material, which is the highest percent of passing samples of any formation investigated in this study.

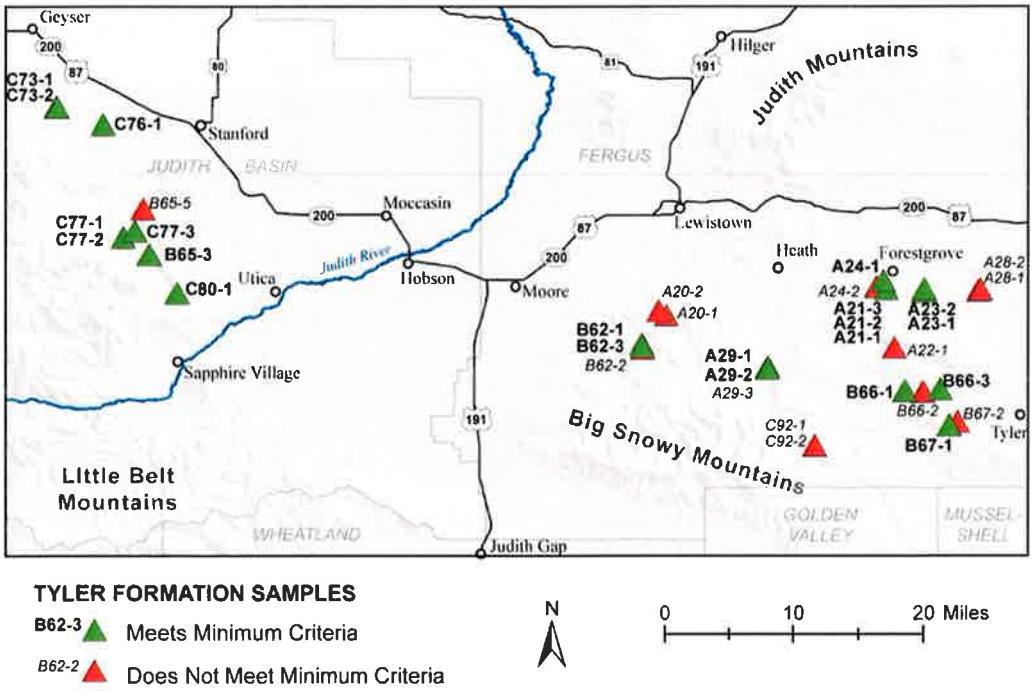

Figure 23 - Sample locations from the Tyler Formation in Fergus and Judith Basin Counties, in central Montana.

These samples were collected in the northeastern part of the Little Belt Mountains and the northern part of the Big Snowy Mountains. Results for all samples that passed the minimum requirements are presented in Table 11.

Sample Name	Latitude	Longitude	County	Mesh Size	Sphericity	Roundness	% Fines				
							5,000 psi	6,000 psi	7,000 psi	8,000 psi	9,000 psi
A21-1	46.97243	-109.09127	Fergus	70/140	0.622	0.592		7.03	9.11	12.28	
A21-2	46.97243	-109.09127	Fergus	70/140	0.623	0.647		8.2	12		
A21-3	46.97243	-109.09127	Fergus	70/140	0.632	0.644		7.6	9.64	13.9	
A22-1	46.907234	-109.077612	Fergus	70/140	0.593	0.553		8	11.4		
A23-1	46.96918	-109.02905	Fergus	70/140	0.638	0.574	9.86	15.91	20.1		
A23-2	46.9721	-109.02908	Fergus	70/140	0.640	0.689		8.45	13.25		
A24-1	46.98163	-109.09573	Fergus	70/140	0.631	0.677		8.9	12.12		
A29-1	46.88687	-109.28395	Fergus	70/140	0.654	0.658			8.5	11.75	
A29-2	46.88415	-109.28497	Fergus	70/140	0.641	0.585		6.63	14.55		
B62-1	46.91205	-109.4917	Fergus	40/70	0.647	0.696	8.7				
B62-3	46.90927	-109.49102	Fergus	70/140	0.625	0.647	5.6				
B65-3	47.00885	-110.2999	Judith Basin	70/140	0.626	0.644		8.2	10.6		
B66-1	46.85882	-109.06102	Fergus	40/70	0.616	0.626	9.3	10	21.3		
B66-3	46.86028	-109.00408	Fergus	70/140	0.627	0.683	8.1	10.6			
B67-1	46.82002	-108.99008	Fergus	70/140	0.644	0.673		4.8	7.1	8.5	10.1
C73-1	47.17187	-110.45433	Judith Basin	70/140	0.640	0.667		5.7	4.4		
C73-2	47.17197	-110.45218	Judith Basin	70/140	0.634	0.680	6.9				
C76-1	47.15337	-110.37785	Judith Basin	70/140	0.639	0.679		9.2	10.5		
C77-1	47.02721	-110.34262	Judith Basin	70/140	0.640	0.657	8.6				
C77-2	47.02729	-110.34235	Judith Basin	70/140	0.636	0.667	6.6				
C77-3	47.03485	-110.32383	Judith Basin	70/140	0.630	0.665	4.4				
C80-1	46.96618	-110.2544	Judith Basin	70/140	0.629	0.679	3.9				

Table 11 - Results from the samples which met the minimum criteria for proppant material from the Tyler Formation. All samples in this table had adequate or nearly adequate sphericity and roundness values.

Sample B67-1 was the only sample in this study that successfully passed crush testing at 8,000 psi, producing 8.5% fines. This sample is located along the north side of South Fork Flatwillow Creek in the Big Snowy Mountains. A nearby sample (B67-2) was collected farther east where a mixture of lithologies were present including shale, conglomerate, limestone and sandstone. This sample failed all crush tests. An example of the 140 mesh quartz grains from sample B67-1 is shown in Figure 24. The quartz grains are rounded (0.673) and spherical (0.644) with good clarity and no lithic fragments.

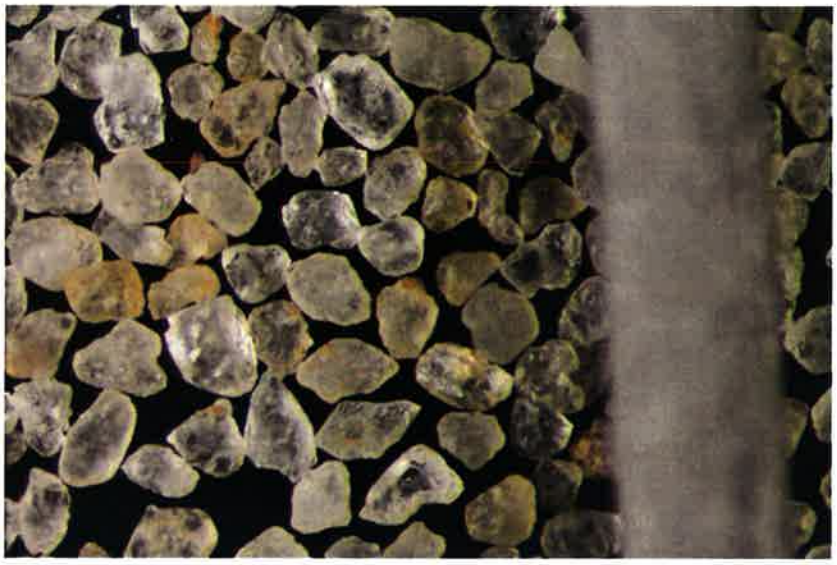

Figure 24 - Microscopic view of sample B67-1 at the 140 mesh size with a 0.5mm pencil lead for scale.

Tyler Formation outcrops on the northeastern side of the Little Belt Mountains appear to contain material with potential for use as a proppant where only one sample (B65-5) failed to meet proppant criteria. B65-5 was the only sample near the Little Belt Mountains with an API size designation larger than 70/140. The sandstones from the Tyler in this area with API size of 70/140 consistently meet minimum criteria for proppant material. In addition, approximately half the samples from the northern Big Snowy Mountains meet minimum criteria for proppant material. The Tyler Formation has the most consistent positive results for proppant material in Montana and is a potential source for quality proppant, with some potential to withstand pressures of up to 8,000 psi.

Kibbey Formation (Mississippian)

Fifteen samples were taken from the Kibbey Formation, most of which were located around the Little Belt Mountains (Figure 25). Sample B64-2 had an API size at 70/140 and was the only Kibbey sample that passed all lab tests. Its sphericity and roundness values were 0.665 and 0.680 respectively; it passed a crush test at 6,000 psi with 9.5% fines produced, then failed at 7,000 psi with 12.7% fines produced. The API grain sizes of the samples from this formation are highly variable and eleven of the fifteen samples failed to meet minimum criteria for proppant material because of the presence of clusters at the designated API sieve sizes. An investigation of the area to the east and south of sample B64-2 could provide a more complete evaluation of this formation.

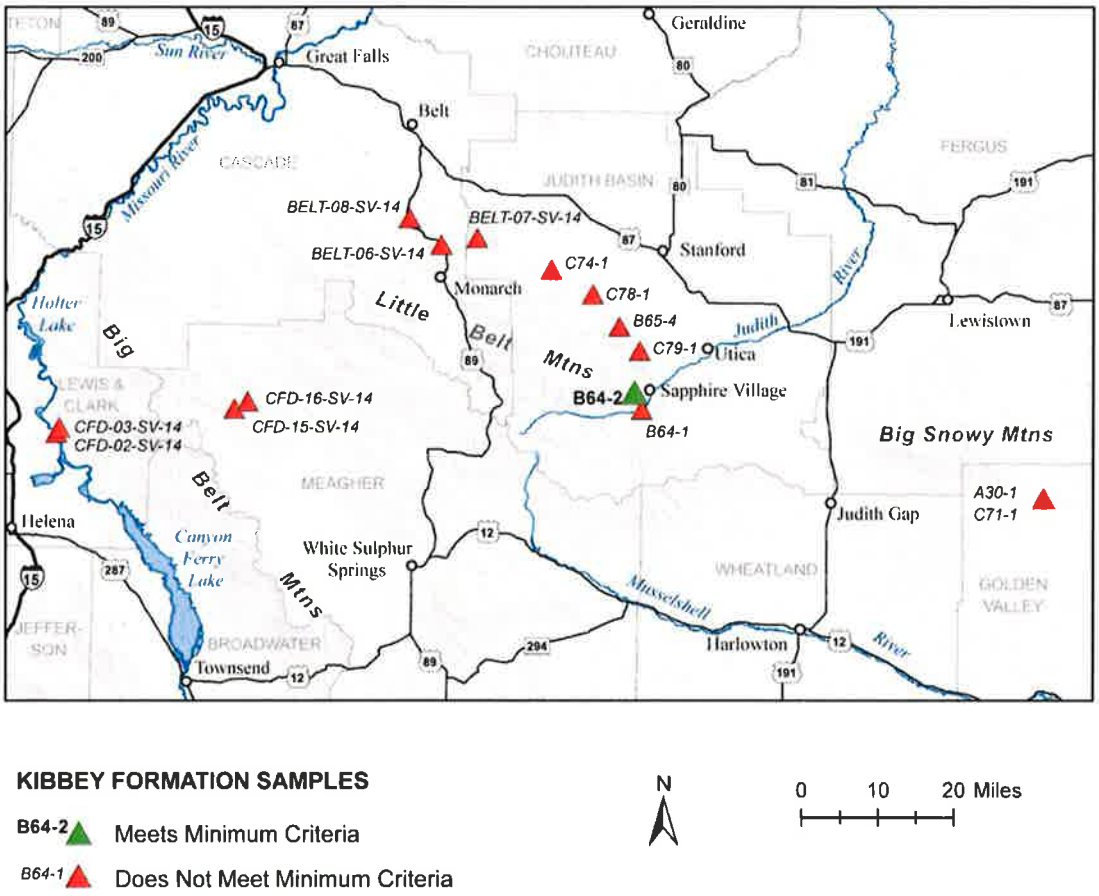

Figure 25 - Kibbey Formation sample locations.

Data for the sample from the Kibbey Formation that passed the minimum API specifications is summarized in summarized in

Table 12 below.

Sample Name	Latitude	Latitude	County	Mesh Size	Sphericity	Roundness	% Fines			
							5,000 psi	6,000 psi	7,000 psi	8,000 psi
B64-2	46.88512	-110.294	JUDITH BASIN	70/140	0.665	0.680		9.5	12.7	

Table 12 – The Kibbey Formation sample that pass our testing sequence showed good sphericity and roundness.

Flathead Formation (Cambrian)

Twenty-five samples were collected and processed from the Lower Cambrian Flathead Formation, the oldest sandstone with proppant potential in Montana. The collection locations for these samples is shown in Figure 26. Four samples met the minimum criteria for proppant. Most of the Flathead samples were collected from the Big Belt and Little Belt Mountains where cementation is the least pronounced, however samples were also taken from Missoula, Jefferson, Gallatin and Powell Counties.

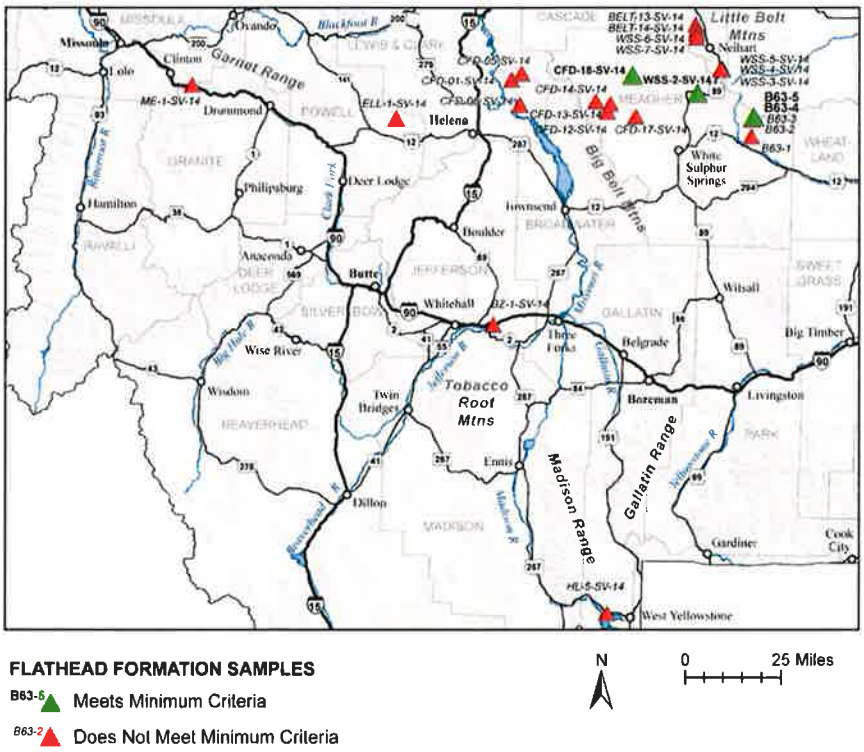

Figure 26 - Flathead Formation sample locations in central and southwestern Montana.

The four samples that passed the lab tests (Table 13) were all located along the southwestern flank of the Little Belt Mountains as indicated by the green icons in Figure 26. Samples which passed crush tests included B63-4 and B63-5. These samples show increased grain size and increased iron staining (perhaps from the presence of hematite) down section. Sample CFD-18 was located farthest west along the southwest side of the Little Belt Mountains and contained abundant limonite specks. This was the only sample which passed a 6,000 psi crush test. The microscopic view of CFD-18 is shown in Figure 27.

Sample Name	Latitude	Latitude	County	Mesh Size	Sphericity	Roundness	% Fines			
							5,000 psi	6,000 psi	7,000 psi	8,000 psi
B63-4	46.68257	-110.49058	MEAGHER	30/50	0.658	0.597	9.4	11.3		
B63-5	46.68257	-110.49058	MEAGHER	40/70	0.647	0.664	7.3	11.7		
CFD-18-SV-14	46.829335	-111.16383	MEAGHER	70/140	0.632	0.587		6.4	10.3	
WSS-02-SV-14	46.767276	-110.804047	MEAGHER	30/50	0.633	0.604	8.9	14.0	20.3	

Table 13 - Summary of the results from the samples which met the minimum criteria for proppant material from the Flathead Formation. The roundness criteria on two of the samples is marginal.

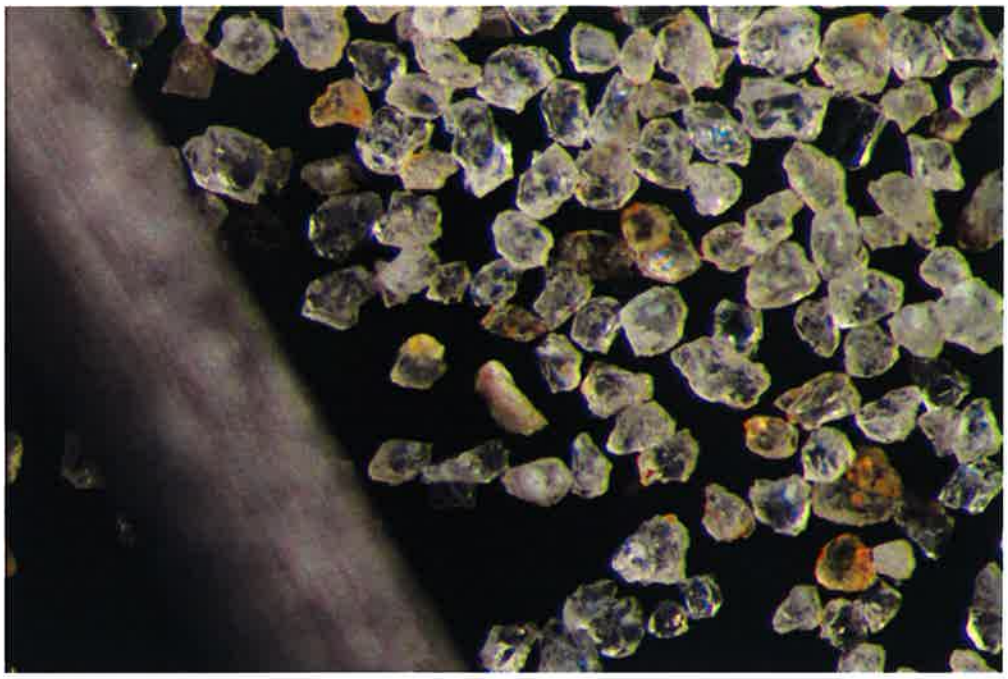

Figure 27 - Sample CFD-18 at 140 mesh size with 0.5mm lead for scale. Primarily composed of quartz with no lithic clasts in this view under the optical microscope. This image may show limonite specks on the grains.

The Flathead Formation on the southwest side of the Little Belt Mountains might prove to be a source of quality proppant sand that can consistently pass 5,000 psi crush tests.

Formations Not Yielding Positive Results

This project was designed to provide guidance on sandstones within the State of Montana that have some promise as sources of proppant material. Perhaps as important as those samples that showed potential, however, are results that indicate formations that are less likely or unlikely to provide viable proppant. Three of the units were initially identified as target sandstones (Virgelle Formation, Fall River Formation, and Flood Member of the Blackleaf Formation). The others were not target sandstones.

This section details the laboratory and geology results for formations that did not meet the minimum API criteria for proppant. Figure 28 shows the general location of the samples for each formation.

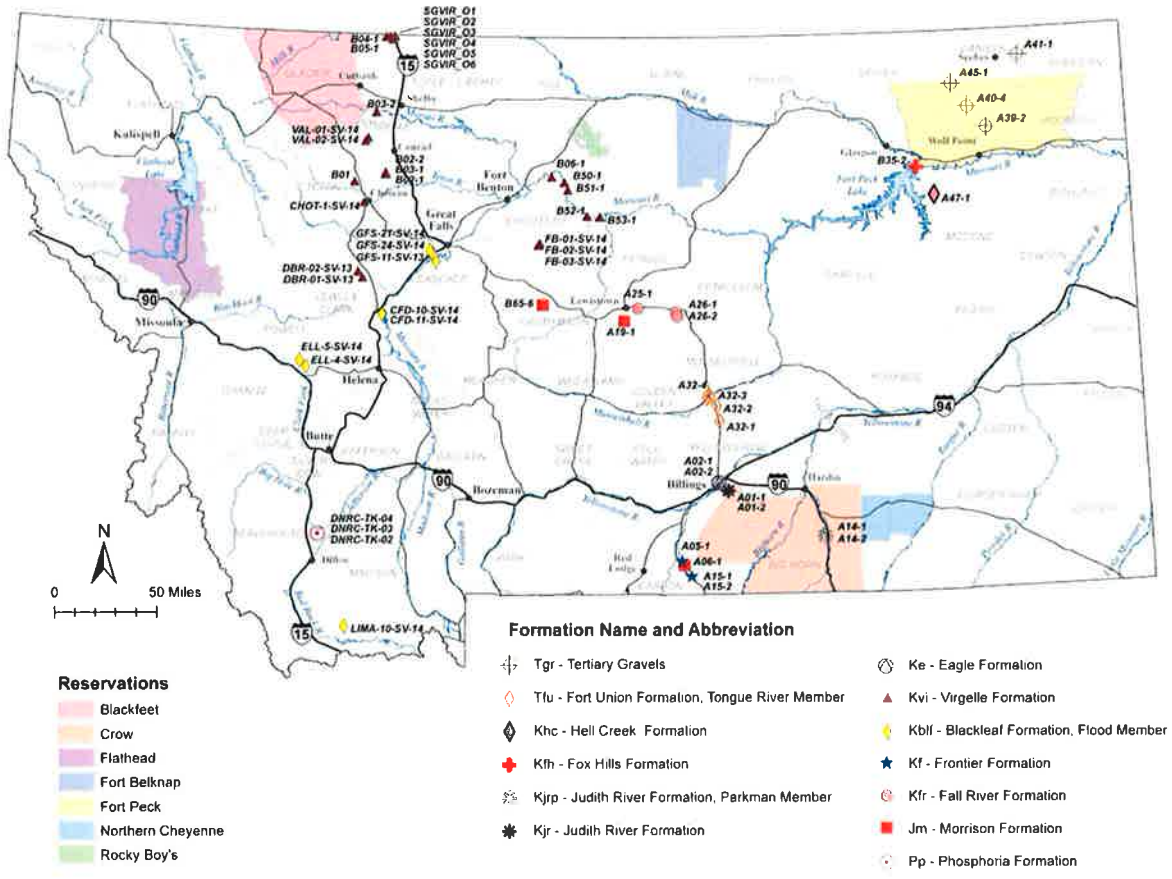

Figure 28 - State-wide map showing sample locations from formations that did not yield promising results

Tongue River Member of Fort Union Formation (Tertiary)

Four samples were collected in Musselshell County (Figure 28) from the Tongue River Member of the Fort Union Formation.

Samples A32-1 and A32-2 contained significant amounts of lithic fragments so further testing was ruled out. Samples A32-3 and A32-4 passed the requirements for sphericity (0.611 and 0.643, respectively) and roundness (0.596 and 0.602, respectively) but failed crush tests at both 5,000 (20.3% and 13.5% fines produced, respectively) and 6,000 psi (21.9% and 15.3% fines produced, respectively). With the high percentage of lithic material and low crush results obtained for these samples, it is unlikely that material from this area will be a viable source of proppant.

Hell Creek Formation (Upper Cretaceous)

Sample A47-1 (Figure 28) from the Hell Creek Formation in McCone County had an API size of 70/140, however when the sample was examined with the optical microscope (Figure 29) it was evident that there were many lithic clasts present. In addition, the grains were angular and did not exhibit adequate sphericity, so further testing was abandoned.

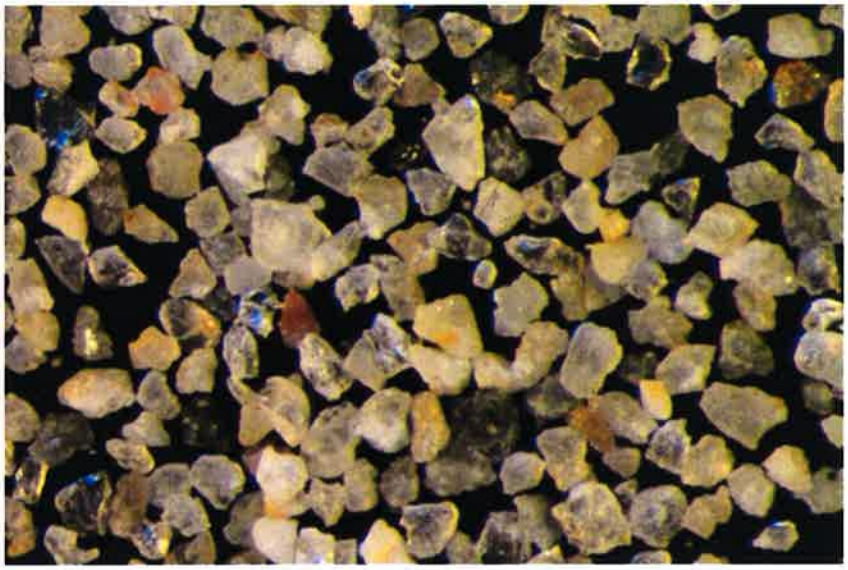

Figure 29 - Hell Creek Formation, sample A47-1, 140 mesh through an optical microscope. Abundant lithic clasts and poor sphericity/roundness means this sample does not pass the minimum requirements for proppant material.

Fox Hills Formation (Upper Cretaceous)

The Fox Hills Formation was sampled in one location in the northwestern corner of McCone County in northeastern Montana (Figure 28.) Although Sample B35-2 showed marginal sphericity (0.603) and roundness (0.587), it failed significantly under pressures of 6,000 and 5,000 psi with 43.9% and 37.9% fines produced, respectively, making it unsuitable for proppant material. The micrograph of the 140 mesh material (Figure 30) showed a significant amount of lithic clasts and several clusters, explaining the poor crush results. Iron staining and other contaminants are also present. If sample B35-2 is typical of the Fox Hills Formation it is unlikely to be a viable source of proppant.

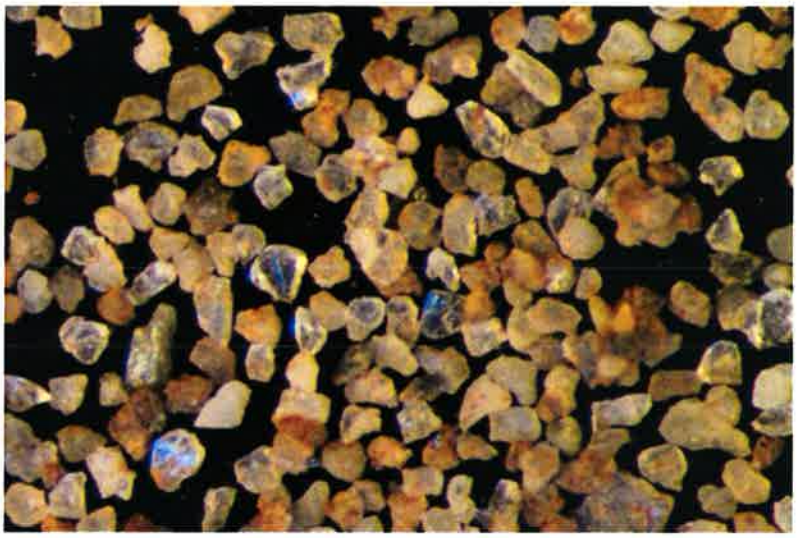

Figure 30 - The 140 mesh retrieval from the Fox Hills Formation sample B35-2, northeastern Montana near Glasgow, shows the large percentage of lithic material in this sample.

Eagle Formation (Upper Cretaceous)

Two Eagle Formation samples, A02-1 and A02-2, were collected from an outcrop in Billings, Montana (Figure 28). The outcrop and a microscopic view of sample A02-1 are shown in Figure 31. The samples have a vertical separation of approximately 13 ft and were divided by the presence of a lightly vegetated area. Both of these samples failed because of grain size in the silt range. Based on the microscopic view, it is evident that the Eagle Formation samples would not pass sphericity and roundness in addition to being too fine grained for potential proppant material.

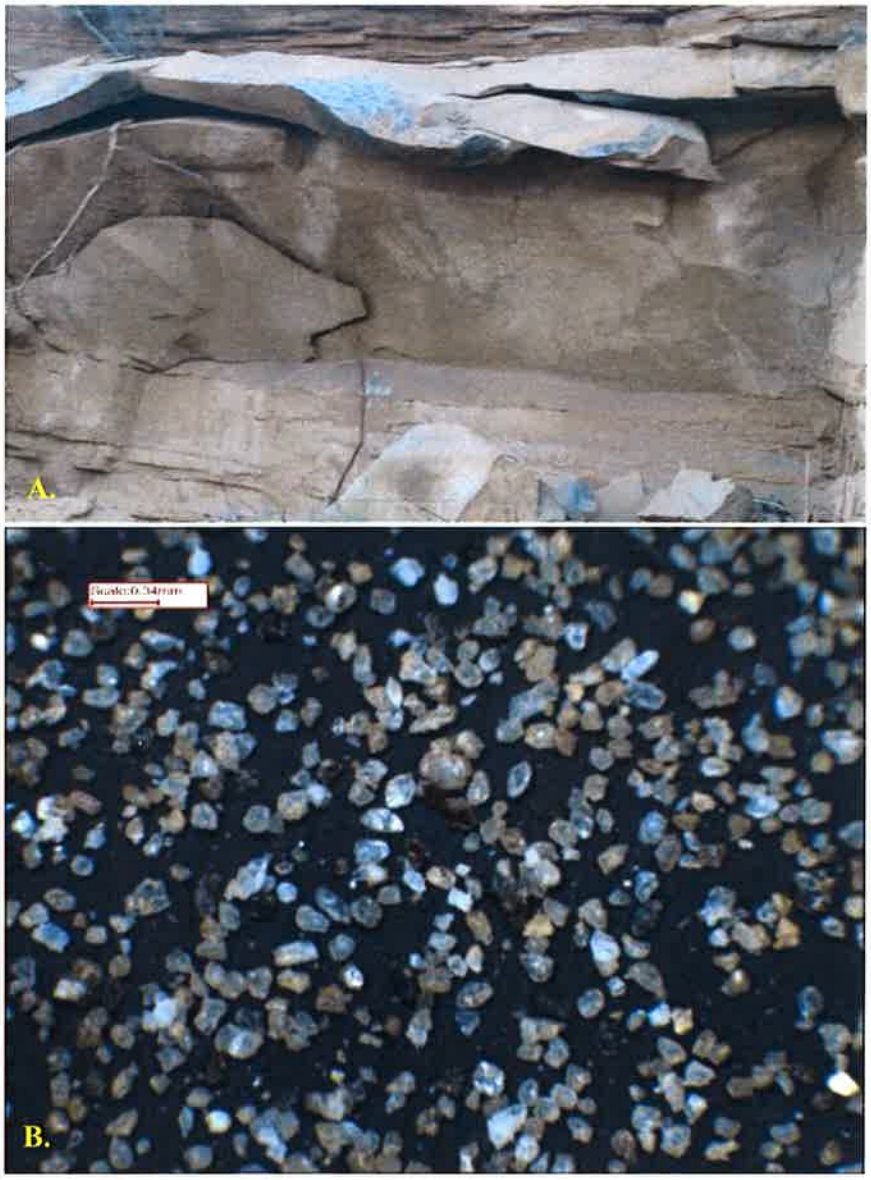

Figure 31 - Eagle Formation at Billings Montana. A] Sample outcrop. B] Disaggregated Eagle Formation sediment. The grains are silt size rather than sand.

Frontier Formation (Upper Cretaceous)

Three samples were collected from the Frontier Formation in southern Montana in Carbon County (Figure 28).

The northernmost sample (A5-01) was determined to be mudstone with lithic clasts and minimal quartz present. Figure 32 shows a field microscopic view of the sample from the Frontier Formation.

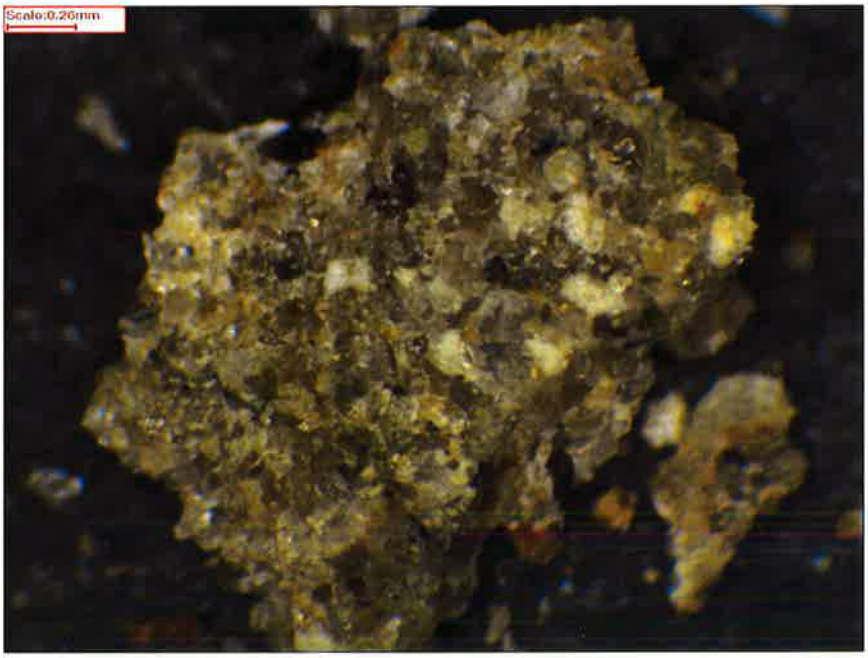

Figure 32 - Frontier Formation, Sample A05-1. A field micrograph shows an abundance of darker matter, indicating that this sample may contain too much lithic material for proppant.

Samples A15-01 and A15-02 were collected from the same outcrop area but sample A15-02 was approximately 7' lower in elevation and on the other side of a gully. Both samples returned API sizes of 70/140 however they were not tested further because of the presence of grain clusters (A15-01) and too many lithic clasts (A15-02) as shown in Figure 33.

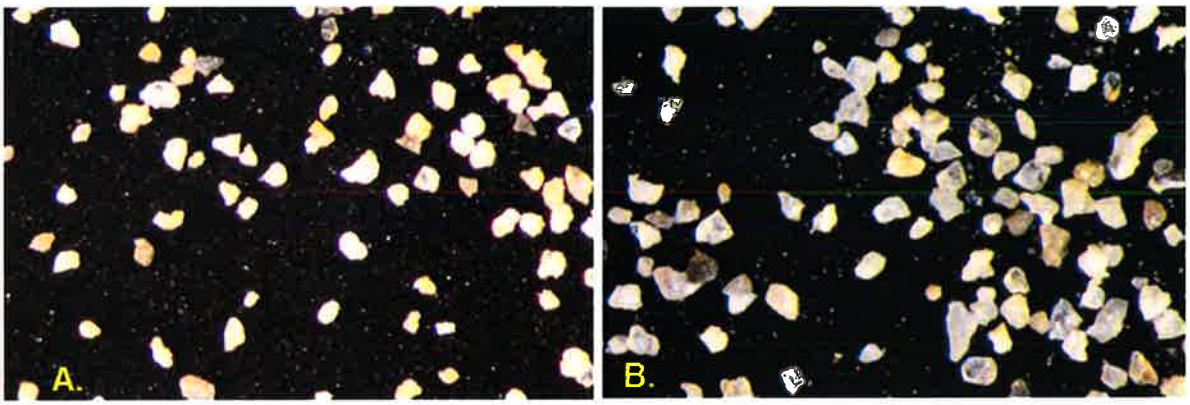

Figure 33 – Frontier Formation A] Sample A15-01 in microscopic view showing the 140 mesh sand grains and clusters. B] Sample A15-02 in microscopic view at 140 mesh size showing angular sand grains with abundant lithic fragments.

Fall River Formation (Lower Cretaceous)

The Cretaceous Fall River Formation, equivalent to the Flood Member of the Blackleaf Formation to the west, was sampled east of Lewistown in Fergus County (Figure 28). Three samples were collected and tested.

The IPSA (CAMSIZER) indicated that the appropriate API sieve size was 70/140, however microscope pictures showed that individual quartz grains are actually smaller. Abundant quartz-grain clusters are visible in the 140 sieve from sample A26-1 (Figure 34).When disaggregated these clusters produced grains that are too small and preclude the Fall River Formation from serving as proppant material – at least at these sample locations.

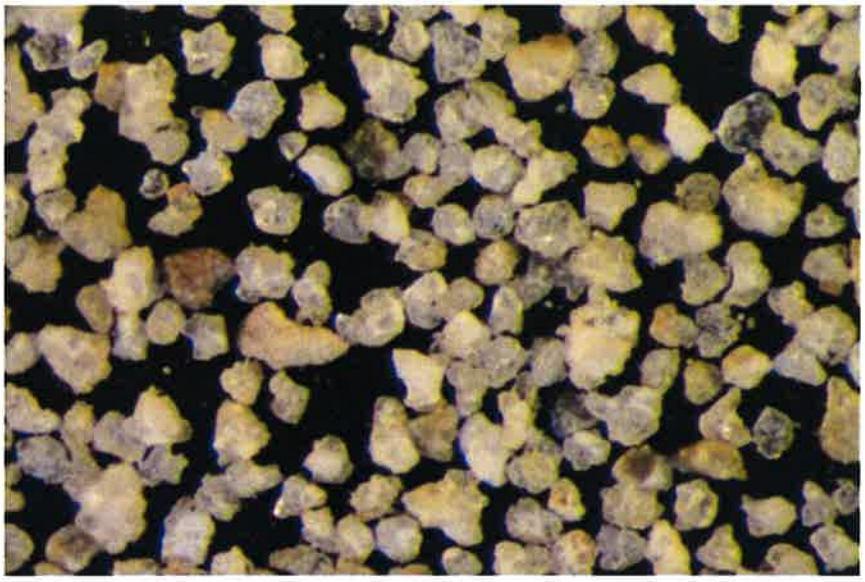

Figure 34 - Sample A26-1 from the Fall River Formation at the 140 mesh size showing a predominance of clusters.

Judith River Formation

Samples A01-1 and A01-2 (Figure 35) from the Judith River Formation were collected from Yellowstone County in southern Montana (Figure 28).

Samples A01-1 and A01-2 failed due to the small grain size. Images of the microscopic views of these samples are shown in (Figure 35).

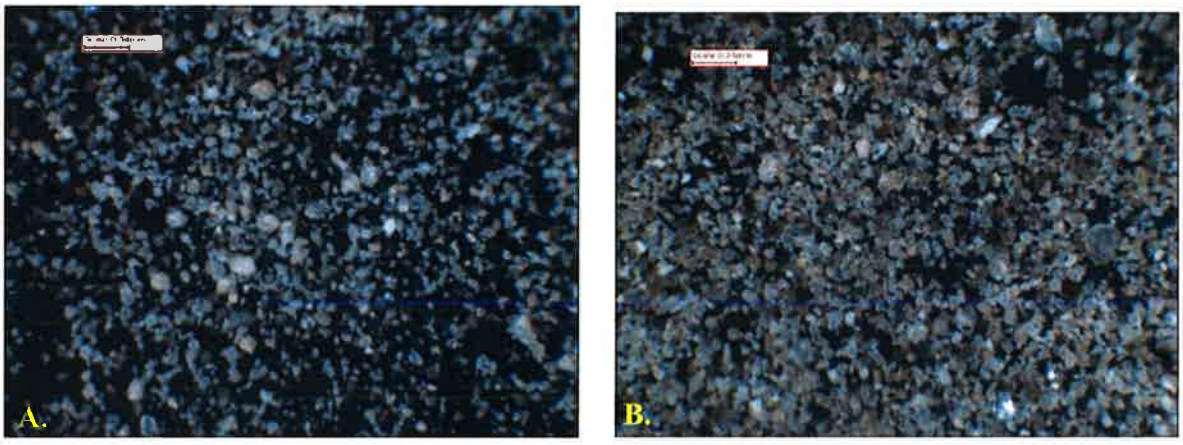

Figure 35 - A] Sample A01-1 through an optical microscope. Grains are too small to warrant further testing. B] Microscopic view of sample A01-2, also demonstrating grains which are too small for potential proppant material.

Judith River Formation: Parkman Member

Two samples (A14-1, 2) were collected from the Parkman Member of the Judith River Formation in Big Horn County, in south-central Montana (Figure 28).The outcrop was composed of sandstone with abundant cross-bedding. The color graded from tan at the bottom to white at the top of the outcrop; this sandstone was very friable. Sample A14-1 was taken from the bottom 10' (tan colored sandstone) of the outcrop and sample A14-2 was taken from the top 30' of the outcrop (white, very fine grained sandstone).

The view under the optical microscope shows the sand does not contain a high enough percentage of quartz to be considered for proppant material. The sphericity for sample A14-1 was 0.581 and the roundness was 0.471 which do not pass the minimum requirements for further testing. Sample A14-2 did not have the sphericity and roundness tested because of the abundance of lithic fragments visible in the microscopic view. Figure 36 shows the outcrop where samples A14-1 and A14-2 were collected. Figure 37 shows sample A14-1 and A14-2 in microscopic view where abundant lithic fragments and angular sand grains are visible.

Figure 36 - Outcrop where samples A14-1 and A14-2 were collected.

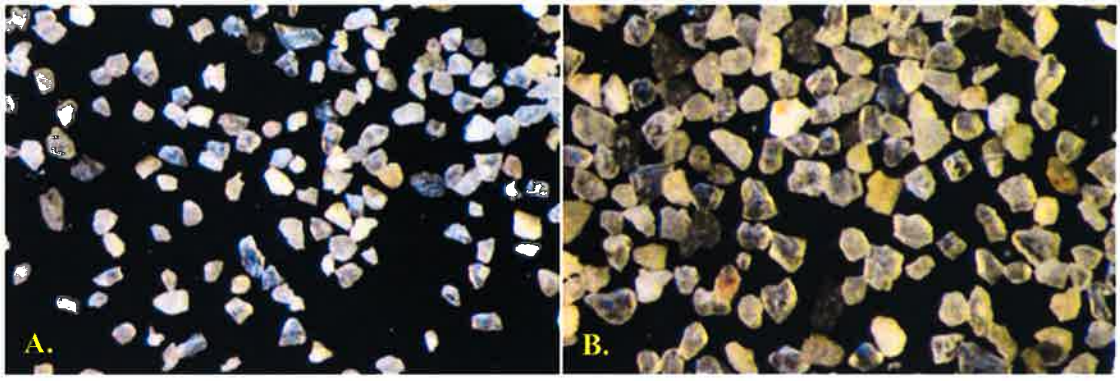

Figure 37 – Judith River Formation; Parkman Member A] Sample A14-1 at the 140 mesh size showing many dark lithic fragments and angular sand grains B] Sample A14-2 at the 140 mesh size showing grains slightly larger and more rounded than A14-1 but with similar amounts of lithic clasts.

Morrison Formation (Jurassic)

Three samples were collected from the Morrison Formation in Carbon, Fergus, and Judith Basin Counties (Figure 28). For the two larger API sizes associated with samples A06-1(40/70) and B65-6 (20/40), the samples contained both clustered material as well as abundant lithic fragments. Sample A19-1 had an API size of 70/140 and passed both sphericity and roundness tests with values of 0.670 and 0.672 respectively. However upon crush testing both at 6,000 psi and 5,000 psi over 25% of fines were produced. The high percentage suggests these Morrison Formation outcrops may not contain potential proppant material.

Blackleaf Formation: Flood Member (Lower Cretaceous)

Eight samples were collected from the Flood Member of the Blackleaf Formation (Figure 28). The material was difficult to completely disaggregate, initially resulting in erroneously large mean size based on the clusters contained in the processed sample.

After complete disaggregation none of the samples passed the minimum requirements primarily due to low sphericity and roundness. The samples with fine to very fine grain size (i.e. API sieve sizes of 70/140) exhibited sphericity and roundness values below the minimum requirements for further testing. Sample LIMA-10 met the sphericity and roundness requirements, however it failed crush tests at both 6,000 and 5,000 psi producing 12.4% and 12.1% fines respectively. LIMA-10, CFD-10, and ELL-04 are the only samples from the Blackleaf Formation which exhibit API mesh sizes of 70/140. The remainder of the samples contained smaller grains.

Virgelle Formation (Upper Cretaceous)

Twenty six samples were collected throughout north-central Montana from the Virgelle Formation (Figure 28). All of the samples failed to meet minimum standards for proppant material. The API sieve size for the Virgelle samples ranges between 20/40 down to 70/140. Twenty of the samples failed due to inadequate sphericity and roundness, the presence of clusters, and/or insufficient silica content. The remaining six samples failed crush tests at 5,000 psi. Based on these samples, the Virgelle Formation in Montana does not appear to be a viable source of proppant material.

Phosphoria Formation (Upper Cretaceous)

Four samples from the Phosphoria Formation (DNRC-TK-01 through 04) were collected in Beaverhead County in southwestern Montana. The sampler's notes describe the DNRC-TK-01 samples as "hi silica cemented, pink, medium to coarse grain size." The sampler noted that DNRC-TK-04 "didn't scratch with a knife."

In the lab these samples were found to be extremely well cemented, making separation of the individual grains impossible. Testing of these samples were not conducted.

Tertiary Gravels

Samples from Tertiary gravels in several locations in northeastern Montana (Valley, Roosevelt, and Daniels Counties) were collected. The locations are shown in Figure 28. In general these samples contained significant amounts of non-silica lithic clasts and performed poorly in the laboratory tests. These samples included A39-2, A40-4, A41-1 and A45-1, among others. The micrograph of the 60 mesh retrieval for sample A40-4 (Figure 38) is typical of these materials.

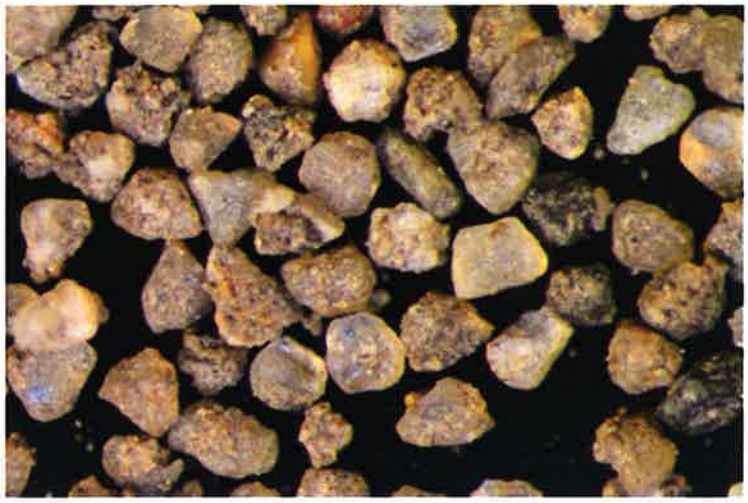

Figure 38 - A 60 mesh retrieval of a Tertiary Gravel sample (A40-4) shows the mixed lithology common to these samples.

Conclusions

Of the formations discussed in this paper, the most promising based on laboratory results is the Tyler Formation. Outcrops in the northeastern part of the Little Belt Mountains and the northeastern part of the Big Snowy Mountains produced material which met and surpassed minimum criteria for proppant.

Samples from the Quadrant Formation in the northeastern part of the Little Belt Mountains and in southwestern Montana near Dillon and Lima also met the minimum requirements for proppant material.

The Tensleep Formation (age equivalent to the Quadrant of western Montana) shows potential in the dune sandstone that is interbedded with massive sandstones in the southern part of Montana, particularly in Carbon County.

The Sunburst member of the Kootenai Formation produced samples which met the minimum criteria for proppant material near Great Falls, Montana.

The Flathead Formation produced some potentially viable proppant material on the south side of the Little Belt Mountains.

Two samples of eolian dune deposits in northeastern Montana met minimum requirements for proppant.

The northeastern flank of the Little Belt Mountains had the greatest concentration of formations which met the minimum requirements for proppant material, including the Kootenai, Quadrant, Tyler, and Kibbey Formations.

This report represents a snapshot in time of the data. While great care was taken to ensure data accuracy, it is likely that errors have crept in. The Montana Bureau of Mines and Geology has accepted responsibility for future maintenance of the data that is available on its web site. Readers are asked to report any errors they might find to the MBMG.

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John Getty, Geophysical Engineering, PI

Catherine McDonald, Montana Bureau of Mines and Geology, Co-PI

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Laboratory Information Management System

Sample Name	Latitude	Longitude	Geomethod	Datum	Elev	TWN	RNG	Sec	Qsec	County	Geo Symbol	Sampler Notes	Thick (ft)	Extent (ft)	Form'n Name	Member	Pre Wash	Post Wash	Tested Mesh Size	P/F	Spher	Roundness	Percent Fines 5K psi	6K psi	7K psi	8K psi	9K psi	>90 % Silica	Clusters
A01-1	45.7448	-108.37801	NAV-	NAD83	3183	01S	27E	15	CA	YELLOWS	Kjr	AT THE PASS; EAST SIDE OF ROAD; A1-1 CHANNEL SS 1/2 WAY UP JUST BELOW GRAVEL FLOAT; ISOLATED CHANNEL SANDS EACH ABOUT 3' THICK	3	30	Judith River		-	-		fail										
A01-2	45.745607	-108.379331	NAV-	NAD83	3183	01S	27E	15	CA	YELLOWS	Kjr	100' N OF A1-1; EAST SIDE OF ROAD; A1-2 MUDDY CHAN SS; SEVERAL CHANNELS	2	20	Judith River		-	-		fail										
A02-1	45.800779	-108.48216	NAV-	NAD83	3139	01N	26E	27	CC	YELLOWS	Ke	EAGLE OUTCROP WEST OF 6TH AVE FLYOVER; 200YDS SO OF APPLEBEES; A2-1 FRIABLE SS LEDGE 15' ABOVE SECOND CLIFF-FORMING SAND; ~100' UP OUTCROP	10	9999	Eagle		-	-		fail										
A02-2	45.801056	-108.481366	NAV-	NAD83	3126	01N	26E	27	CC	YELLOWS	Ke	EAGLE OUTCROP WEST OF 6TH AVE FLYOVER; 150YDS SO OF APPLEBEES; A2-2 10-15' DOWN FROM TOP OF LEDGE FORMED BY MAIN CLIFF SAND; HARD SS; SCALLOPED WEATHERING PATTERN	35	9999	Eagle		-	-		fail										
A03-1	45.495766	-108.665436	NAV-	NAD83	4094	04S	25E	8	C	CARBON	Kkg	N 5-6 MI ON COTTONWOOD CK RD FROM E. PRYOR RD EAST OF EDGAR; A3-1 LOWER CHANNEL, FRIABLE F GRND QTZ SS ; CHANNEL 100' TOTAL THICKNESS, LOWEST STRAT SAMPLE 50' DOWN FROM TOP	10	5000	Kootenai	Greybull	-	-	40/60	fail				15.1				Yes	No
A03-2	45.496226	-108.665233	NAV-	NAD83	4101	04S	25E	8	C	CARBON	Kkg	N 5-6 MI ON COTTONWOOD CK RD FROM E. PRYOR RD EAST OF EDGAR; A3-2 10-15' HIGHER;	20	5000	Kootenai	Greybull	-	-	40/60	pass	0.626	0.683	5.0	20.2				Yes	No
A03-3	45.496713	-108.664506	NAV-	NAD83	4107	04S	25E	8	C	CARBON	Kkg	N 5-6 MI ON COTTONWOOD CK RD FROM E. PRYOR RD EAST OF EDGAR; A3-3 10-15' HIGHER, X-BEDDED, THINNER BEDDING;	20	5000	Kootenai	Greybull	-	-	40/70	pass	0.630	0.633	6.7	21.1				Yes	No
A03-4	45.497528	-108.664609	NAV-	NAD83	4096	04S	25E	8	C	CARBON	Kkg	N 5-6 MI ON COTTONWOOD CK RD FROM E. PRYOR RD EAST OF EDGAR; A3-4 15-20' HIGHER (NEAR TOP); OIL-STAINED	15	5000	Kootenai	Greybull	-	-	40/70	fail	0.631	0.579	18.3	34.5				Yes	No
A04-1	45.438394	-108.693753	NAV-	NAD83	4550	04S	25E	31	C	CARBON	Kkg	E FROM EDGAR ON E. PRYOR RD TO WHERE HEAD OF WOLF CREEK CROSSES ; A4-1 NORTH SIDE OF ROAD; OUTCROPS ALL ALONG WOLF CREEK TO THE NORTH	20	5000	Kootenai	Greybull	-	-	40/60	pass	0.634	0.689	10.0	15.6				Yes	No
A05-1	45.24315	-108.86183	MAP	NAD83	3815	07S	23E	12	B	CARBON	Kf	NE SIDE OF PRYOR MTN RD - D. CAMPBELL FARM; 125 YDS BEYOND DRIVEWAY ON NE SIDE OF ROAD	20	9999	Frontier		-	-	20/40	fail								No	NA
A06-1	45.211811	-108.835326	NAV-	NAD83	4037	07S	24E	19	CA	CARBON	Jm	WEST FLANK RED DOME ALONG PRYOR MTN RD; A6-1 VERY FINE GRAINED QTZ SS (AEOLIAN?); OCCURS IN LENSES IN MORRISON	15	75	Morrison		-	-	40/70	fail								Yes	Yes
A07-1	45.242186	-108.673945	NAV-	NAD83	5017	07S	25E	9	BD	CARBON	IPt	EAST ON PRYOR MTN RD TO INTSC W/ RAILROAD GRADE RD NEAR SAGE CK; CLIFF FACE TO N; A7-1 LOWER VF GRND DUNE QTZ SS; A7-2 OVERLYING REWKED MARINE SS (CALC CMT); SAMP DUNE AND OVERLYING UNIT, EACH 10' THICK	20	9999	Tensleep		-	-	70/140	pass	0.633	0.641		7.8	17.3			Yes	No
A07-2	45.242186	-108.673945	NAV-	NAD83	5017	07S	25E	9	BD	CARBON	IPt	EAST ON PRYOR MTN RD TO INTSC W/ RAILROAD GRADE RD NEAR SAGE CK; CLIFF FACE TO N; OVERLYING REWKED MARINE SS (CALC CMT); SAMP DUNE AND OVERLYING UNIT, EACH 10' THICK	20	9999	Tensleep		-	-	70/140	fail	0.656	0.662	18.9	19.8				Yes	No
A07-3	45.242362	-108.673909	NAV-	NAD83	5388	07S	25E	9	BD	CARBON	IPt	EAST ON PRYOR MTN RD TO INTSC W/ RAILROAD GRADE RD NEAR SAGE CK; CLIFF FACE TO N; A7-3 NEXT DUNE UP SECTION; A7-4 MASSIVE OVERLYING XBEDS; XBEDS (A7-4) CAPPED BY MORE MASSIVE REWORKED SANDY LIME; ALL OF A7 SAMPLED IN ~10' INTERVALS	15	9999	Tensleep		-	-	70/140	pass	0.635	0.602	9.6	12.1	13.8			Yes	No
A07-4	45.242186	-108.673945	NAV-	NAD83	5388	07S	25E	9	BD	CARBON	IPt	EAST ON PRYOR MTN RD TO INTSC W/ RAILROAD GRADE RD NEAR SAGE CK; CLIFF FACE TO N; MASSIVE OVERLYING UNIT - XBEDS; XBEDS (A7-4) CAPPED BY MORE MASSIVE REWORKED SANDY LIME; ALL OF A7 SAMPLED IN ~10' INTERVALS	15	9999	Tensleep		-	-	70/140	fail	0.655	0.598	11.7	12.9				Yes	No
A08-1	45.281561	-108.694484	NAV-	NAD83	5429	06S	25E	30	D	CARBON	IPt	2.5 MI UP SECTION HOUSE DRAW TO NW; OUTCROP SW SIDE ; A8-1 WELL SORTED MASSIVE FRIABLE VF QTZ DUNE SS - YELLOWISH COLOR ; 30' DUNE, 10 LIMEY SS, 15' FRIABLE DUNE SS (A8-2?)	30	9999	Tensleep		-	-	70/140	fail	0.636	0.641	13.3					Yes	No
A09-1	45.205594	-108.728083	NAV-	NAD83	4648	07S	24E	24	DC	CARBON	IPt	SO SIDE PRYOR MTN RD EAST OF RED DOME, 1 MI. NE OF BLACK BUTTE; A9-1 VARIABLE FRIABLE AND LIMEY VF QTZ SS;	10	500	Tensleep		-	-	70/140	fail	0.659	0.649	11.3	13.5				Yes	No
A10-1	45.398115	-108.6846	NAV-	NAD83	4753	05S	25E	18		CARBON	Kkg	2-3 MI SO OF PRYOR RD ALONG WEST BNDRY CROW RES; TRIBUTARY OF 5-MI CK; A10-1 E EDGE OF CHANNEL ON RES, NEAR TOP, XBEDDED 7-8' THICK; TOTAL CHANNEL ABOUT 100' THICK AT THIS LOCATION; HOODOOS; PRONOUNCED IRON STAINING	100	9999	Kootenai	Greybull	-	-	40/70	fail	0.610	0.561	15.4	22.3				Yes	No
A10-2	45.398361	-108.687503	NAV-	NAD83	4690	05S	25E	18	AA	CARBON	Kkg	2-3 MI SO OF PRYOR RD ALONG WEST BNDRY CROW RES; TRIBUTARY OF 5-MI CK; A10-2 1/4 MI WEST, LOWEST SAMPLE, 20' LOW TO HOODOO LEDGE; TOTAL CHANNEL ABOUT 100' THICK AT THIS LOCATION; HOODOOS; PRONOUNCED IRON STAINING	100	9999	Kootenai	Greybull	-	-	40/70	fail	0.626	0.546	24.0	26.1	38.0			Yes	No
A10-3	45.398601	-108.685905	NAV-	NAD83	4771	05S	25E	18		CARBON	Kkg	2-3 MI SO OF PRYOR RD ALONG WEST BNDRY CROW RES; TRIBUTARY OF 5-MI CK; A10-3 MID-CHANNEL (VERT) 10' ABOVE HOODOO LEDGE, PLANAR BED BTW XBEDS; TOTAL CHANNEL ABOUT 100' THICK AT THIS LOCATION; HOODOOS; PRONOUNCED IRON STAINING	100	9999	Kootenai	Greybull	-	-	40/60	fail	0.628	0.636	16.3	16.9	23.1			Yes	No
A11-1	45.373215	-108.372394	NAV-	NAD83	4926	05S	27E	27	BA	BIG HORI	IPt	E PRYOR CK TO S, SECONDARY RD TO S BTW HAY & E PRYOR CKS; A11-1 MASSIVE OR THIN PLANAR BEDDING, FRIABLE QTZ SS; JUST ACROSS FENCE LINE AT HAIRPIN TURN TO W	10	500	Tensleep		-	-	70/140	fail	0.639	0.628	11.3					Yes	No
A11-2	45.372861	-108.371829	NAV-	NAD83	4863	05S	27E	27	BA	BIG HORI	IPt	E PRYOR CK TO S, SECONDARY RD TO S BTW HAY & E PRYOR CKS; A11-2 DOWN HILL OVER LEDGE 50' BELOW A11-1; THIN/MED BEDDED, XBEDS TOWARD W; ALONG CREEK	15	2000	Tensleep		-	-	70/140	fail	0.627	0.661	24.3	27.2				Yes	No
A12-1	45.370352	-108.050441	NAV-	NAD83	3907	05S	30E	30	AA	BIG HORI	IPt	EAST FLANK GRAPEVINE DOME; 500' WEST OF ROAD; A12-1 THIN-BEDDED VF QTZ SS; BIOTURBATED AT TOP;	30	2000	Tensleep		-	-	70/140	fail	0.634	0.668	14.5	18.3				Yes	No
A13-1	45.334974	-107.985904	NAV-	NAD83	3475	06S	30E	1	AB	BIG HORI	IPt	600' SO. OF INDIAN RD ON GRAPEVINE CK; NEAR POWER LINE CROSSES; A13-1,2,3 UP SECTION; 15' DUNE, 15' DUNE; TOP 10' THINBEDS; 3 SAMPS, PHOSPHORIA(?) CAPS THE UNIT; TENSLEEP EXTENDS ALONG GRAPEVINE CK	40	9999	Tensleep		-	-	70/140	fail	0.622	0.621	27.3	31.4				Yes	No

Sample Name	Latitude	Longitude	Geomethod	Datum	Elev	TWN	RNG	Sec	Qsec	County	Geo Symbol	Sampler Notes	Thick (ft)	Extent (ft)	Form'n Name	Member	Pre Wash	Post Wash	Tested Mesh Size	P/F	Spher	Roundness	Percent Fines 5K psi	6K psi	7K psi	8K psi	9K psi	>90 % Silica	Clusters
A13-2	45.334974	-107.985904	NAV-	NAD83	3475	06S	30E	1	AB	BIG HORI	IPt	600' SO. OF INDIAN RD ON GRAPEVINE CK; NEAR POWER; 15' DUNE, 15' DUNE, TOP; 3 SAMPS, PHOSPHORIA(?) CAPS THE UNIT; TENSLEEP	40	9999	Tensleep		-	-	40/70	fail	0.630	0.610	13.6	34.0				Yes	No
A13-3	45.334974	-107.985904	NAV-	NAD83	3475	06S	30E	1	AB	BIG HORI	IPt	3 SAMPS, PHOSPHORIA(?) CAPS THE UNIT; TENSLEEP EXTENDS ALONG GRAPEVINE CK; UP SECTION; 15' DUNE, 15' DUNE; TOP 10' THINBEDS	40	9999	Tensleep		-	-	70/140	fail	0.646	0.656	19.7	21.1	35.1			Yes	No
A14-1	45.404316	-107.393725	NAV-	NAD83	3219	05S	35E	16	AA	BIG HORI	Kjrp	SAND CK RD JUST WEST FROM I90 FRONTAGE RD 7MI N OF LODGEGRASS; A14-1 LOWER TAN 10' F-M XBEDDED SS; A14-2 UPPER 30' WHITE VF-F XBEDDED SS; 300-400 YDS N OF SAND CK; THESE SANDS ARE MOSTLY UNCONSOLIDATED	40	750	Judith Rive	Parkman	-	-	40/70	fail	0.581	0.471						No	No
A14-2	45.404316	-107.393725	NAV-	WGS84	3219	05S	35E	16	AA	BIG HORI	Kjrp	SAND CK RD JUST WEST FROM I90 FRONTAGE RD 7MI N OF LODGEGRASS; UPPER 30' WHITE VF-F XBEDDED SS; 300-400 YDS N OF SAND CK; THESE SANDS ARE MOSTLY UNCONSOLIDATED	40	9999	Judith Rive	Parkman	-	-	70/140	fail								No	No
A15-1	45.133675	-108.763269	NAV-	NAD83	4246	08S	24E	15	DD	CARBON	Kf	EAST SIDE HWY310 16 SO OF BRIDGER; JUST ACROSS BRIDGE; A15-1 THIN-BEDDED (UP TO 1-2') VF-F S&P LITHIC SS; IRON WISPS & CONCRETIONS;	20	9999	Frontier		-	-	70/140	fail								Yes	Yes
A15-2	45.133273	-108.763439	NAV-	NAD83	4239	08S	24E	15	DD	CARBON	Kf	EAST SIDE HWY310 16 SO OF BRIDGER; JUST ACROSS BRIDGE; A15-2 UP SECTION 20-25' (75-100YDS TO W); FRIABLE VF LITHIC SS; 5' BELOW UPPER CAPPING SS	10	9999	Frontier		-	-	70/140	fail								No	No
A16-1	45.07639	-108.527255	NAV-	NAD83	5339	09S	26E	3	CD	CARBON	IPt	BEAR CANYON WHERE ROAD TURNS TO N-NE; TRANSECT UP EAST RIDGE; JUST ABOVE CONTACT (10') WITH UNDERLYING AMSDEN; START TRANSECT UP EAST RIDGE; TOTAL STRAT THICKNESS ~200'	200	9999	Tensleep		-	-	70/140	fail								yes	yes
A16-2	45.07639	-108.527255	NAV-	NAD83	5339	09S	26E	3	CD	CARBON	IPt	DUNE SAND ALONG A16 TRANSECT; BEAR CANYON WHERE ROAD TURNS TO N-NE; TRANSECT UP EAST RIDGE; TRANSECT UP EAST RIDGE FROM GPS A16-1 TO GPS A16-5; TOTAL STRAT THICKNESS ~200'	200	9999	Tensleep		-	-	70/140	fail	0.623	0.636	27.7	39.3				Yes	No
A16-3	45.07639	-108.527255	NAV-	NAD83	5339	09S	26E	3	CD	CARBON	IPt	BEAR CANYON WHERE ROAD TURNS TO N-NE; TRANSECT UP EAST RIDGE; DUNE SAND ALONG A16 TRANSECT; TRANSECT UP EAST RIDGE FROM GPS A16-1 TO GPS A16-5; TOTAL STRAT THICKNESS ~200'	200	9999	Tensleep		-	-	70/140	fail	0.656	0.635	31.4	32.3				Yes	No
A16-4	45.07639	-108.527255	NAV-	NAD83	5339	09S	26E	3	CD	CARBON	IPt	BEAR CANYON WHERE ROAD TURNS TO N-NE; TRANSECT UP EAST RIDGE; DUNE SAND ALONG A16 TRANSECT ; TRANSECT UP EAST RIDGE FROM GPS A16-1 TO GPS A16-5; TOTAL STRAT THICKNESS ~200'	200	9999	Tensleep		-	-	70/140	fail	0.639	0.658	20.3	24.3				Yes	No
A16-5	45.075792	-108.526812	NAV-	NAD83	5488	09S	26E	3	CD	CARBON	IPt	BEAR CANYON WHERE ROAD TURNS TO N-NE; TRANSECT UP EAST RIDGE; END TRANSECT, DUNE SANDS NEAR TOP OF TENSLEEP; END TRANSECT UP EAST RIDGE; TOTAL STRAT THICKNESS ~200'	200	9999	Tensleep		-	-	70/140	fail	0.638	0.622	25.5	35.6				Yes	No
A16-6	45.075792	-108.526812	NAV-	NAD83	5488	09S	26E	3	CD	CARBON	IPt	BEAR CANYON WHERE ROAD TURNS TO N-NE; TRANSECT UP EAST RIDGE; END TRANSECT, THIN GREENISH SS NEAR TOP OF TENSLEEP; END TRANSECT UP EAST RIDGE; TOTAL STRAT THICKNESS ~200'	200	9999	Tensleep		-	-	70/140	fail	0.642	0.619	16.0	16.6				Yes	No
A17-1	45.078739	-108.546365	NAV-	NAD83	5316	09S	26E	4	CA	CARBON	IPt	MOUTH OF BEAR CANYON WHERE RD TURNS FROM NE TO E; TRANSECT UP NORTH FACE; SAMPLED TYPICAL DUNE SANDS; GPSTOP OF RIDGE, SAMPLED FROM TOP OF RIDGE (A17-1) DOWN TO ROAD (A17-5); ~200'	200	9999	Tensleep		-	-	40/70	fail	0.624	0.568	28.1	27.8	30.0			Yes	No
A17-2	45.078739	-108.546365	NAV-	NAD83	5316	09S	26E	4	CA	CARBON	IPt	MOUTH OF BEAR CANYON WHERE RD TURNS FROM NE TO E; TRANSECT UP NORTH FACE; TYPICAL DUNE SANDS; GPSTOP OF RIDGE, SAMPLED FROM TOP OF RIDGE (A17-1) DOWN TO ROAD (A17-5); ~200'	200	9999	Tensleep		-	-	70/140	fail	0.631	0.650	13.9	18.0				Yes	No
A17-3	45.078739	-108.546365	NAV-	NAD84	5316	09S	26E	4	CA	CARBON	IPt	MOUTH OF BEAR CANYON WHERE RD TURNS FROM NE TO E; TRANSECT UP NORTH FACE; TYPICAL DUNE SAND; GPSTOP OF RIDGE, SAMPLED FROM TOP OF RIDGE (A17-1) DOWN TO ROAD (A17-5); ~200'	200	9999	Tensleep		-	-	70/140	fail	0.622	0.618	12.2	16.8	22.5			Yes	No
A17-4	45.078739	-108.546365	NAV-	NAD83	5316	09S	26E	4	CA	CARBON	IPt	MOUTH OF BEAR CANYON WHERE RD TURNS FROM NE TO E; TRANSECT UP NORTH FACE; TYPICAL SAND DUNE; GPSTOP OF RIDGE, SAMPLED FROM TOP OF RIDGE (A17-1) DOWN TO ROAD (A17-5); ~200'	200	9999	Tensleep		-	-	70/140	fail	0.633	0.662	13.0	15.2				Yes	No
A17-5	45.078739	-108.546365	NAV-	NAD83	5316	09S	26E	4	CA	CARBON	IPt	MOUTH OF BEAR CANYON WHERE RD TURNS FROM NE TO E; TRANSECT UP NORTH FACE; A17-1 (TOP) TO A17-5 (BOT) SAMPLED TYPICAL DUNE SANDS; GPSTOP OF RIDGE, SAMPLED FROM TOP OF RIDGE (A17-1) DOWN TO ROAD (A17-5); ~200'	200	9999	Tensleep		-	-	70/140	fail	0.629	0.643	22.1	26.6				Yes	No
A18-1	47.196349	-109.219299	NAV-	NAD83	5587	17N	20E	31	AB	FERGUS	Kk	SW SIDE OF BIG GRASSY PEAK, JUDITH PEAK RD, JUDITH MTNS; A18-1 MED GRND CMTD LITHIC SS; BED ORIENTATION 110/31 DEGREES (DIP S); LAMINATED LIGHT/DARK SANDS	30	200	Kootenai		-	-	30/50	FAIL	0.587	0.426						Yes	Yes
A19-1	46.96813	-109.452883	NAV-	WGS84	4406	14N	18E	21	BA	FERGUS	Jm	CASINO CK RD SO OF LEWISTOWN; EAST SIDE OF RD; A19-1 ORANGE-TAN SPECKLED SS; HARD, CEMENTED, LIMONITE, TABULAR BEDS	10	250	Morrison		-	-	70/140	fail	0.670	0.672	28.8	28.5				Yes	No
A20-1	46.94435	-109.45187	NAV-	WGS85	4714	14N	18E	28	CA	FERGUS	IPM	INTERSECTION OF CASINO CK RD (CUTOFF) AND COTTONWOOD CK RD; A20-1 HARD TABULAR BEDS W/ WOOD FRAGS; RED-BR MED SS, FRIABLE NEAR TOP; SUSAN'S PT#30	15	100	Tyler		-	-	40/70	fail	0.630	0.655	12.4	20.3				Yes	No
A20-2	46.94868	-109.464783	NAV-	WGS86	4734	14N	18E	29	AD	FERGUS	IPM	NEAR Y JUNCTION 3/4 MI NW OF A20-1 ON COTTONWOOD CK RD; A20-2 LIGHT-COLORED CALC MUDSTONE W/ MUDCRACKS, LITTLE TYLER ON TOP; SUSAN'S PT#19	5	100	Tyler		-	-	40/70	fail								No	Yes
A21-1	46.97243	-109.09127	NAV-	WGS87	4225	14N	21E	17	CA	FERGUS	IPM	1.75 MI SW OF FOREST GROVE ON SURENOUGH CK RD; A21-1 NEAR TOP (N) FRIABLE WHITE FG SS, XBEDS, CONC; A21-2 & A21-3 NEAR BASE OF MASSIVE UNIT 5-10' BELOW A21-1; SUSAN'S PT#1	10	500	Tyler		-	-	70/140	pass	0.622	0.592		7.0	9.1	12.3		Yes	No
A21-2	46.97243	-109.09127	NAV-	WGS88	4225	14N	21E	17	CA	FERGUS	IPM	A21-2 NEAR BASE OF MASSIVE UNIT 5-10' BELOW A21-1; 1.75 MI SW OF FOREST GROVE ON SURENOUGH CK RD	10	500	Tyler		-	-	70/140	pass	0.623	0.647		8.2	12.0			Yes	No

Sample Name	Latitude	Longitude	Geomethod	Datum	Elev	TWN	RNG	Sec	Qsec	County	Geo Symbol	Sampler Notes	Thick (ft)	Extent (ft)	Form'n Name	Member	Pre Wash	Post Wash	Tested Mesh Size	P/F	Spher	Roundness	Percent Fines 5K psi	6K psi	7K psi	8K psi	9K psi	>90% Silica	Clusters
A21-3	46.97243	-109.09127	NAV-	WGS84	4225	14N	21E	17	CA	FERGUS	IPMt	1.75 MI SW OF FOREST GROVE ON SURENOUGH CK RD; A21-3 NEAR BASE OF MASSIVE UNIT 5-10' BELOW A21-1;	10	500	Tyler		-	-	70/140	pass	0.632	0.644		7.6	9.6	13.9		Yes	No
A22-1	46.907234	-109.077612	MAP	NAD83	5198	13N	21E	9	BB	FERGUS	IPMt	SURENOUGH RD GOING E 1000' BEYOND N FORK RD TO S; A22-1 RED-STAINED F GRND QTZ SS, HEAVILY WEATHERED; 850' N OF ROAD, ~300YDS UP HILL FROM OTTER OC ON LEFT	25	1500	Tyler		-	-	70/140	PASS	0.593	0.553		8.0	11.4			Yes	No
A23-1	46.96918	-109.02905	NAV-	WGS84	4275	14N	21E	14	CD	FERGUS	IPMt	FAIRVIEW RD GOING NORTH, 2.5 MI SO OF FOREST GROVE RD ; A23-1 HARD, WEATHERED, REDDISH SS OVERLYING BLACK FISSILE SHALE E OF RD; BTW SUSAN'S PT#33 & 39	10	1000	Tyler		-	-	70/140	pass	0.638	0.574	9.9	15.9	20.1			Yes	No
A23-2	46.9721	-109.02908	NAV-	WGS84	4186	14N	21E	14	CA	FERGUS	IPMt	1000' N OF A23-1, 30 YDS UP HILL TO E; A23-2 WHITE FRIABLE SS ; SUSAN'S PT#39	10	500	Tyler		-	-	70/140	pass	0.640	0.689		8.5	13.3			Yes	No
A24-1	46.98163	-109.09573	NAV-	WGS84	4209	14N	21E	17	BB	FERGUS	IPMt	1 MI SW OF FOREST GROVE ON TYLER CK RD; A24-1 WHITE FRIABLE QTZ SS; SUSAN'S PT#4; OBSCURE OC ON NW SIDE OF RD	8	100	Tyler		-	-	70/140	pass	0.631	0.677		8.9	12.1			Yes	No
A24-2	46.97487	-109.106717	NAV-	WGS84	4265	14N	21E	18	AC	FERGUS	IPMt	3/4 MI SW OF A24-1 ON TYLER CK RD; A24-2 DARK COLORED QTZ SS - OIL STAIN?; TABULAR BEDDING. FRIABLE ; SUSAN'S PT#5	15	300	Tyler		-	-	70/140	fail	0.644	0.663	33.1	36.0				Yes	No
A25-1	47.05962	-109.30935	NAV-	WGS84	4472	15N	19E	15	CB	FERGUS	Kfr	2 MI EAST OF BOYD CK ALONG US87 EAST OF LEWISTOWN; A25-1 FINELY LAMINATED YELLOW RUST VF GRND SS W/ SMALL SCALE XBEDS;	5	100	Fall River		-	-	70/140	fail								Yes	Yes
A26-1	47.0298	-108.905917	NAV-	WGS84	3691	15N	22E	26	CC	FERGUS	Kfr	1.25 MI SO OF US87 ON MUNGER LN AT CREEK CROSSING; A26-1 THIN-BEDDED (1-12") WHT/YLW LAM VF SS; PERVASIVE SMALL-SCALE XBEDS; SCATTERED OC ALONG DRAINAGE (EA 200-300' WIDE)	15	200	Fall River		-	-	70/140	fail								Yes	Yes
A26-2	46.99803	-108.89857	NAV-	WGS84	3950	14N	22E	2	CD	FERGUS	Kfr	3.5 MI SO OF US87 ON MUNGER LN; A26-2 SMALL OC AT BASE OF DECENT OFF "PLATEAU", MORE FRIABLE?; FEW SMALL OC SCATTERED ALONG HILLSIDE, COULD BE UPPER KK	5	100	Fall River		-	-	70/140	fail								Yes	Yes
A27-1	46.99497	-108.8996	NAV-	WGS84	3894	14N	22E	11	BA	FERGUS	Kk	1/4 MI SO OF A26-2 IN THE TREES; A27-1 S&P LITHIC MED GRND SS, FRIABLE, TABULAR BEDDING; MIDWAY THOUGH KK - 2ND CAT?, EXTENDS LATERALLY	6	75	Kootenai		-	-	40/70	fail	0.639	0.541	17.5	22.0	27.7			Yes	No
A28-1	46.96983	-108.940717	NAV-	WGS84	4006	14N	22E	16	CD	FERGUS	IPMt	1.5 MI SO ON DIXON RD; BRANCH RIGHT & CROSS ATHERTON CK; A28-1 WHITE VF SS W/ RED HMTITE SPOTS, BANDED WHITE/PURPLE; OVERLYING BLACK FISSILE SHALE	8	200	Tyler		-	-	70/140	fail	0.648	0.684	16.0					Yes	No
A28-2	46.9711	-108.93742	NAV-	WGS84	4003	14N	22E	16	DB	FERGUS	IPMt	SAME AS A28-1 ACROSS TRIBUTARY TO N; A28-2 MASSIVE BEDS, WHITE FRIABLE SS; OC ALONG DRAINAGE FOR 1/4 MI; FRAC SET TREND 65°	10	1500	Tyler		-	-	70/140	fail	0.643	0.640	14.4	16.8	17.0			Yes	No
A29-1	46.88687	-109.28395	NAV-	WGS84	5033	13N	19E	14	CA	FERGUS	IPMt	RED HILL RD, 1/2 MI SW OF INTERSECTION W/ AK BENCH RD; A29-1 VF GRND BLK/YLW SPOTTED SS; TYLER BEDS IN SLUMP DEPOSIT (QLS); E SIDE OF RD, MOSTLY OVERGROWN	5	100	Tyler		-	-	70/140	pass	0.654	0.658			8.5	13.8		Yes	No
A29-2	46.88415	-109.28497	NAV-	WGS84	5007	13N	19E	14	CC	FERGUS	IPMt	RED HILL RD 1/4 SW OF A29-1; 100 YDS SO OF MI POST 19; TYLER BEDS IN SLUMP DEPOSIT (QLS); A29-2 BASE OF UPPER WHITE, FRIABLE SS; A29-3 LOWER RED-BROWN UNIT (HEM?); SUSAN'S PT#47?	25	200	Tyler		-	-	70/140	pass	0.641	0.585		6.6	14.6			Yes	No
A29-3	46.88415	-109.28497	NAV-	WGS84	5002	13N	19E	14	CC	FERGUS	IPMt	RED HILL ROAD 1/4 SW OF A29-1; 100 YDS SO OF MI POST 19; TYLER BEDS IN SLUMP DEPOSIT (QLS); LOWER RED-BRWN UNIT (HEM?)	25	200	Tyler		-	-	40/70	fail	0.642	0.618	20.0	35.0	34.0			Yes	No
A30-1	46.6865	-109.16327	NAV-	WGS84	5090	11N	20E	26	AC	GOLDEN	Mk	SO. ON RED HILL RD, ABOUT 4 MI N OF THE "T" ENTERING SNOWIES FROM THE SO.; A30-1 VERY LIMEY SS - PROBABLY KIBBEY BASED ON GPS LOC & GEOL MAP; NOT SURE OF FM - THOUGHT IT MIGHT BE TYLER	5	100	Kibbey		-	-	70/140	fail								Yes	Yes
A31-1	45.01635	-108.50602	NAV-	WGS84	4790	09N	26E	35	BA	CARBON	Kkg	1.5 MI SO OF GYP SPRINGS RD, SO END PRYORS; WHITE QTZ SS VARIABLY IRON-STAINED, A31-1 20' ABOVE BASE CHAN; A31-2 20' BELOW TOP CHANNEL; STATELINE CHNL; EXTENSIVE X-BEDS & FE STAINING; HOODOOS	60	4000	Kootenai	Greybull	-	-	40/70	pass	0.630	0.604		8.6	11.7			Yes	No
A31-2	45.01635	-108.50602	NAV-	WGS84	4810	09N	26E	35	BA	CARBON	Kkg	1.5 MI SO OF GYP SPRINGS RD, SO END PRYORS; A31-2 20' BELOW TOP CHANNEL; WHITE QTZ SS VARIABLY IRON-STAINED; STATELINE CHNL; EXTENSIVE X-BEDS & FE STAINING; HOODOOS	60	4000	Kootenai	Greybull	-	-	40/70	fail	0.635	0.548	12.0					Yes	No
A32-1	46.24092	-108.46128	NAV-	WGS84	3986	06N	26E	27	CB	MUSSELS	Tftr	TOP OF FIRST LARGE HILL GOING N ON HWY87, ~17 MI SO OF RONDUP, EAST SIDE OF HWY | MASSIVE SS W/ LRG SCALE CHNLS & XBEDS, VF GRND YELW SS (QTZ+FSP?) SUB-RND GRNS		500	Fort Union	Tongue	-	-	70/140	fail								YES	YES
A32-2	46.35687	-108.49272	NAV-	WGS84	3474	07N	26E	17	DA	MUSSELS	Tftr	INTERSECTION OF HWY87 & JOHNNY COAL RD | MASSIVE, HARD SS, F-MED GRND, SOME MUD RIP-UP CLASTS & SHELLS	20	300	Fort Union	Tongue	-	-	70/140	fail								YES	No
A32-3	46.41945	-108.56075	NAV-	WGS84	3313	08N	25E	26	BD	MUSSELS	Tftr	BEHIND (EAST) OF MIRACLE LODGE 84 CEMETARY, EAST SIDE HWY87 NEAR KLEIN | SOFT, FRIABLE LITHIC SS, FINE-GRND, BEDS TABULAR TO MASSIVE		200	Fort Union	Tongue	-	-	70/140	fail	0.611	0.596	20.3	23.9				Yes	No
A32-4	46.41322	-108.59302	NAV-	WGS84	3307	08N	25E	28	DD	MUSSELS	Tftr	2 MI WEST OF HWY87 & HWY 12 INTERSECTION ON US12, N SIDE OF HWY | FRESH OUTCROP, INTERBED SS & SHALE 2-10' THICK W/ SOME CHANNELS, SAMP LOW IN CLIFF, F-M GRND LITHIC SS	10	300	Fort Union	Tongue	-	-	70/140	fail	0.643	0.602	13.5	15.3				Yes	No
A33-1	46.86162	-108.68897	NAV-	WGS84	3737	13N	24E	28	BD	FERGUS	Kk	13 MI SO OF GRASSRANGE, JCT OF PIKE CK & KINNICK COULEE HWY 87, E SIDE OF RD, TOP | YLW IRON-STND MED GRND WELL-RND QTZ SS, LOOKS A LOT (AND WEATHERS) LIKE GREYBULL SS	3	100	Kootenai		-	-	70/140	pass	0.642	0.611		4.0	7.7	11.3		Yes	No
A34-1	48.43167	-107.00332	NAV-	WGS84	2264	31N	36E	23	AC	VALLEY	Qe	4 MI EAST OF HINSDALE ON HWY 2, 2 MI N ON BURNS RD | GLACIAL AEOLIAN DUNE SS, DITCH SAMPLE			Eolian		-	-	40/70	fail								No	No
A35-1	48.15773	-105.13497	NAV-	WGS84	#####	28N	51E	28	AB	ROOSEVE	Qe	NE OF POPLAR, 2.75 MI E, 3 MI N, RD 17-2058 | GLACIAL AEOLIAN DUNE SS, DITCH SAMPLE			Eolian		-	-	70/140	fail								No	No
A35-2	48.1578	-105.09697	NAV-	WGS84	#####	28N	51E	23	AB	ROOSEVE	Qe	NE OF POPLAR, 4.5 MI E, 3 MI N, IRREGATION CANAL, RD 17-2058 | GLACIAL AEOLIAN DUNE SS, TILLED FIELD SAMPLE			Eolian		-	-	70/140	fail								No	No

Sample Name	Latitude	Longitude	Geomethod	Datum	Elev	TWN	RNG	Sec	Qsec	County	Geo Symbol	Sampler Notes	Thick (ft)	Extent (ft)	Form'n Name	Member	Pre Wash	Post Wash	Tested Mesh Size	P/F	Spher	Roundness	Percent Fines					>90% Silica	Clusters
																							5K psi	6K psi	7K psi	8K psi	9K psi		
A35-3	48.2052	-105.1155	NAV-	WGS84	#####	28N	51E	3	DB	ROOSEVE	Qe	EAST POPLAR OIL FIELD, 3.5 MI E, 6.25 MI N OF POPLAR | GLACIAL AEOLIAN DUNE SS, TILLED FIELD SAMPLE			Eolian		-	-	70/140	fail								No	No
A35-4	48.20145	-105.13458	NAV-	WGS84	#####	28N	51E	4	DD	ROOSEVE	Qe	EAST POPLAR OIL FIELD, 2.75 MI E, 6 MI N OF POPLAR | GLACIAL AEOLIAN DUNE SS, TILLED FIELD SAMPLE			Eolian		-	-	70/140	fail								No	No
A35-5	48.15777	-104.98207	NAV-	WGS84	#####	28N	52E	27	AA	ROOSEVE	Qe	TURN N AT 2-MILE HILL RD 1048, N 2 MI. | GLACIAL AEOLIAN DUNE SS, ROAD SAMPLE & 2' CORE. SHOVEL SAMPLE			Eolian		-	-	70/140	fail								ND	No
A36-1	48.13713	-104.20168	NAV-	WGS84	#####	28N	58E	35	BD	ROOSEVE	Qe	1 MI SE OF BAINVILLE ON HWY327 - ROAD TO FT. UNION | "OUTCROP" ON SE SIDE OF RD, SHOVEL SAMPLE			Eolian		-	-	70/140	fail								No	No
A36-2	48.1285	-104.348	NAV-	WGS84	#####	27N	57E	3	BB	ROOSEVE	Qe	WEST OF LANARK, 1 MI SO ON 17-1013, 1/2 MI TO WEST | GLACIAL AEOLIAN DUNE SS, N SIDE, FIELD SAMPLE, SILTY			Eolian		-	-	70/140	fail								No	No
A37-1	48.3026	-104.5147	NAV-	WGS84	#####	30N	55E	36	CC	ROOSEVE	Qe	2 MI SO OF FROID, 3/4 MI WEST OF HWY 16 | GLACIAL AEOLIAN DUNE SS, DITCH SAMPLE, 2' CORE SAMPLE			Eolian		-	-	40/70	fail	0.613	0.616	14.9	17.1				Yes	No
A37-2	48.33148	-104.5196	NAV-	WGS84	#####	30N	55E	23	DD	ROOSEVE	Qe	1 MI WEST OF FROID ON HWY 344, 1/2 MI SO | GLACIAL AEOLIAN DUNE SS, CORE FROM 1-3', UPPER 0.5' DIRTY, LOWER 1 5' CLEAN, YLW, COARSE			Eolian		-	-	40/70	fail								no	no
A38-1	48.47648	-104.25938	NAV-	WGS84	#####	31N	57E	1	BB	SHERIDA	Qe	SANDHILLS RD 2 MI EAST OF CAPENEYS LAKE | GLACIAL AEOLIAN DUNE SS, HARD - COULD NOT CORE, SHOVEL SAMPLE			Eolian		-	-	40/70	fail								no	no
A38-2	48.42565	-104.21662	NAV-	WGS84	#####	31N	58E	20	BC	SHERIDA	Qe	COUNTY LINE RD EAST, 2.5 MI N ON DAGMAR RD TO SANDHILLS BMA SIGN | GLACIAL AEOLIAN DUNE SS, SHOVEL SAMPLE, CAN'T GET TO DUNES			Eolian		-	-	70/140	pass	0.622	0.659	9.3	10.1				Yes	No
A38-3	48.38948	-104.30852	NAV-	WGS84	#####	31N	57E	33	DD	SHERIDA	Qe	COUNTY LINE RD 8.75 MI EAST OF HWY 16 | GLACIAL AEOLIAN DUNE SS, SHOVEL SAMPLE N SIDE OF RD			Eolian		-	-	70/140	pass	0.618	0.659	7.7	12.0				Yes	No
A39-1	48.29978	-105.53665	NAV-	WGS84	#####	29N	48E	6	BB	ROOSEVE	Qe	HWY13 12.5 MI N OF HWY2, 3 MI W ON 2048, 1/2 MI S ON 17-1069 | GLACIAL AEOLIAN DUNE SS, SHOVEL SAMPLE SILTY SAND			Eolian		-	-	70/140	fail								No	No
A39-2	48.3003	-105.56043	NAV-	WGS84	#####	29N	47E	1	BB	ROOSEVE	Qe	HWY13 12.5 MI N OF HWY2, 4 MI W ON 2048 | GLACIAL OUTWASH/GRAVELS, MIXED SS, GRVL & COBBLES (FLAXVILLE?)			Eolian		-	-	70/140	fail								No	No
A40-1	48.45063	-105.99198	NAV-	WGS84	#####	31N	44E	10	CD	VALLEY	Qe	N ON FRAZIER-RICHLAND RD, 1/3 MI E ON WALL ST, S SIDE OF RD NEAR FARMHOUSE | GLACIAL AEOLIAN DUNE SS, SHOVEL SAMPLE VF-GRND SILTY SAND, MUDDY			Eolian		-	-	40/70	fail								No	Yes
A40-2	48.45062	-105.93532	NAV-	WGS84	#####	31N	44E	12	AA	VALLEY	Qe	3 MI E OF FRAZ-RICH RD, INTERSECTION WALL ST & ACADEMY, SW CORNER | GLACIAL AEOLIAN DUNE SS, SHOVEL SAMPLE VF-GRND SAND, MUDDY			Eolian		-	-	40/70	fail								No	No
A40-3	48.45032	-105.83803	NAV-	WGS84	#####	31N	45E	14	BA	VALLEY	Qe	7.5 MILES E OF FRAZ-RICH RD ON WALL ST. | GLACIAL AEOLIAN DUNE SS, SHOVEL SAMPLE FG SAND			Eolian		-	-	40/70	fail								No	No
A40-4	48.45028	-105.74925	NAV-	WGS84	#####	31N	46E	16	AB	ROOSEVE	Qe	11.5 MI E OF FRAZ-RICH RD ON WALL ST. (17-2038), 1/2 MI E OF INTERSEC W/ 17-1079 | GLACIAL TILL, SANDY W/ ABUNDANT GRAVEL (FLAXVILLE) - POOR SAMPLE			Eolian		-	-	40/70	fail								No	No
A40-6	48.4662	-105.6268	NAV-	WGS84	#####	31N	47E	5	DA	ROOSEVE	Qe	18.5 MI E OF FRAZ-RICH RD ON WALL ST. (17-2038), 1/4 MI N ON TWO-TRACK | GLACIAL AEOLIAN DUNE VF-GRND SANDY, SHOVEL SAMP ON RD, CORE SAMP 1-2.5' IN FIELD			Eolian		-	-	70/140	fail								No	No
A41-1	48.80193	-105.18558	NAV-	WGS84	#####	35N	50E	9	CA	DANIELS	Qe	1/2 MI W OF FLAXVILLE ON HWY 5, OC ON S SIDE | STRAT UNCON SAND W/ GRVL STRGRS, FG, ANG, S&P (FLUVIAL?), SOME ZONES CMT W/ PEBBLES	20		Eolian		-	-	40/70	fail								No	No
A41-2	48.76613	-105.24737	NAV-	WGS84	#####	35N	49E	24	CD	DANIELS	Qe	2.5 MI S AND 3.5 MI W OF FLAXVILLE | GLACIAL AEOLIAN DUNE SS, SHOVEL SAMPLE SANDY W/ A FEW PEBBLES			Eolian		-	-	40/70	fail								No	No
A41-3	48.85217	-105.27812	NAV-	WGS84	#####	36N	49E	26	BB	DANIELS	Qe	3.5 MI N OF HWY5 ON THE "MADOC RD" | GLACIAL AEOLIAN DUNE SS, SHOVEL SAMPLE, SANDY SURFACE - MUDDIER BELOW			Eolian		-	-	40/70	fail								No	No
A42-1	48.76605	-105.54083	NAV-	WGS84	#####	35N	47E	22	CC	DANIELS	Qe	4.5 MI W OF SCOBEY ON HWY 5, 3.5 MI S | GLACIAL AEOLIAN DUNE SS, SHOVEL SAMPLE, VF, ANG GRNS			Eolian		-	-	40/70	fail								No	No
A43-1	48.76593	-105.80647	NAV-	WGS84	#####	35N	45E	22	DD	DANIELS	Qe	1 MI S AND 1 MI E OF PEERLESS, S SIDE OF RD 150 YDS FROM INTERSECTION | GLACIAL AEOLIAN DUNE SS, SHOVEL SAMPLE IN PIT, NICE SAND			Eolian		-	-	70/140	fail								No	No
A44-1	48.68183	-105.93393	NAV-	WGS84	#####	34N	44E	22	DD	DANIELS	Qe	FROM WEST FORK, 1 MI S, 1 MI W, 1/2 MI N, WHEAT FIELD | GLACIAL AEOLIAN DUNE SS, CLEAN ROAD SAMPLE, CORE SAMPLE			Eolian		-	-	70/140	fail								ND	Yes
A45-1	48.61705	-105.91198	NAV-	WGS84	#####	33N	44E	14	AD	DANIELS	Qe	5 MI S OF WEST FORK | GLACIAL, SANDY DITCH SAMPLE BUT FLAXVILLE? IN NEARBY HILL CUT			Eolian		-	-	40/70	fail								No	No
A46-1	48.57742	-105.99923	NAV-	WGS84	#####	33N	44E	31	AA	DANIELS	Qe	5 MI W OF HAUGEN'S HILL | GLACIAL AEOLIAN DUNE SS, SHOVEL SAMPLE			Eolian		-	-	40/70	fail								No	No
A47-1	47.82927	-106.14188	NAV-	WGS84	#####	24N	43E	24	AB	MCCONE	Khc	10 MI S OF FT PECK ON HWY24 AT MILE POST 35, E SIDE OF ROAD | VF GRND, SUB-ANG TO SUB-RND, WELL-SORTED, QTZ+LITHICS, UNCONSOL SS; LRG-SCALE XBEDS	15	250	Hell Creek		-	-	70/140	fail								No	No
B01	47.940283	-112.33983	NAV-	WGS84	#####	25N	06W	11		TETON	Kvi	VERY SOFT, BROWN & WHITE, NOT VERY EXPOSED	THIN		Virgelle		-	-	40/70	fail								No	No
B02-1	48.000623	-112.006074	NAV-	WGS84	2920	26N	03W	17		TETON	Kvi	VERY SOFT, WHITE; REACTS TO ACID	~50		Virgelle		-	-	70/140	fail								No	No
B02-2	48.012221	-112.003479	NAV-	WGS84	2513	26N	03W	16		TETON	Kvi	-	50		Virgelle		-	-	40/70	fail								No	No
B03-1	48.012221	-112.003479	NAV-	WGS84	3866	26N	03W	16		TETON	Kvi	SOFT, WHITE, REACTS TO ACID	~40	MILES	Virgelle		-	-	20/40	fail								Yes	Yes
B03-2	48.43991	-112.12527	NAV-	WGS84	3870	31N	04W	16		PONDER	Kvi	CLOSE TO TOP OF FORMATION; SOFT			Virgelle		-	-	70/140	fail								Yes	Yes
B04-1	48.985783	-112.04463	NAV-	WGS84	3550	37N	03W	7		GLACIER	Kvi	THIN VERTICAL LAYERS, SOFT, WHITE, REACTS TO ACID	30		Virgelle		-	-	40/70	fail								No	Yes
B05-1	48.9868	-112.001983	NAV-	WGS84	3481	37N	03W	7		SWEET G	Kvi	ROAD CUT, SOFT, WHITE, REACTS TO ACID	15		Virgelle		-	-	70/140	fail								No	Yes
B06-1	48.000379	-110.2244	NAV-	WGS84	2611	26N	12E	19		CHOUTE	Kvi	HARDER WITH JUNK IN IT (CHIRT?), WHITE, REACTS TO ACID	40		Virgelle		-	-	40/60	FAIL	0.621	0.528						Yes	No

Sample Name	Latitude	Longitude	Geomethod	Datum	Elev	TWN	RNG	Sec	Qsec	County	Geo Symbol	Sampler Notes	Thick (ft)	Extent (ft)	Form'n Name	Member	Pre Wash	Post Wash	Tested Mesh Size	P/F	Spher	Roundness	Percent Fines 5K psi	6K psi	7K psi	8K psi	9K psi	>90 % Silica	Clusters
B35-2	48.03049	-106.31563	NAV-	WGS84	2680	26N	42E	4	DD	MCCONE	Kfh	RADIO TOWER HILL 2 MI EAST OF FT PECK SPILLWAY | OVERLYING "CAP UNIT", RED-BROWN SOFT SS	10	300	Fox Hills		-	-	70/140	fail	0.603	0.587	37.9	43.9				Yes	No
B49-1	45.27866	-107.92266	MAP	NAD83	4020	06S	31E	28	CD	BIG HORI	IPt	HAIRPIN CURVES FROM FT. SMITH TO OKEBEE; FINE GRND TENSLEEP SS	40	9999	Tensleep		380.1	333.7	70/140	fail	0.631	0.656						Yes	Yes
B50-1	47.96253	-110.09137	NAV-	WGS84	2520	26N	13E	32	C	CHOUTEA	Kvi	FIRST MASSIVE WHITE CLIFF AT RIVER EDGE ON NE SIDE OF RIVER; WHITE FRIABLE VIRGELLE SS	70	400	Virgelle		314.8	238.7	70/140	fail	0.614	0.575						Yes	Yes
B51-1	47.90848	-110.0524	NAV-	WGS84	2549	25N	13E	21	AD	CHOUTEA	Kvi	EAGLE CREEK - NEAR ENTRANCE TO SLOT CANYON ; WHITE FRIABLE VIRGELLE SS	100	9999	Virgelle		343.8	275.7	70/140	fail	0.621	0.586	12.6	13.8				Yes	No
B52-1	47.72052	-109.84762	NAV-	WGS84	2588	23N	15E	31	DA	CHOUTEA	Kvi	SLAUGHTER RIVER 1/4 MI NORTH OF CAMPING AREA; WHITE FRIABLE VIRGELLE SS	40	200	Virgelle		292.4	204.4	40/70	fail	0.631	0.534						Yes	Yes
B53-1	47.71328	-109.70812	NAV-	WGS84	2424	23N	16E	32	DC	CHOUTEA	Kvi	CLIFFS ON NW (LEFT) SIDE OF RIVER , 3/4 MI ABOVE DEADMAN'S RAPIDS; WHITE FRIABLE VIRGELLE SS	75	300	Virgelle		432.7	385	70/140	fail	0.636	0.600	17.3					YES	YES
B56-1	45.09765	-108.58402	NAV-	WGS84	5033	08S	26E	31	AD	CARBON	IPt	1 MI ON HELT RD; TURN LEFT AND GO 1 MI TO NE ON TWO-TRACK ; VF GRND QTZ SAND; SBEDS W/ CALCITE CMT	15	9999	Tensleep		285.8	99	70/140	fail	0.649	0.686		14.2				YES	Yes
B56-2	45.09648	-108.58505	NAV-	WGS84	5013	08S	26E	31	AD	CARBON	IPt	1 MI ON HELT RD; TURN LEFT AND GO 1 MI TO NE ON TWO-TRACK ; YELLOW VF GRND QTZ SAND W/ OXIDATION BANDS AND PEA TO MARBLE SIZED CALCITE-RICH NODULES	20	9999	Tensleep		497.5	212.1	70/140	Fail	0.652	0.658						Yes	Yes
B57-1	45.09027	-108.57377	NAV-	WGS84	5102	08S	26E	32	CC	CARBON	IPt	1 MI OFF HELT RD ON STOCKMAN TRAIL; FRIABLE VF GRND QTZ SAND, LARGE XBEDS JUST ABOVE TABULAR BEDS OF LIMEY SS LOW IN SECTION; TOTAL OC 100' THICK; 15-20' DUNE PACKAGES CAPPED BY 10-15' THICK CALCAREOUS TABULAR SS	100	9999	Tensleep		341.2	332.5	70/140	fail	0.635	0.654		6.0	7.7	12.8		Yes	Yes
B57-2	45.09038	-108.5738	NAV-	WGS84	5131	08S	26E	32	CC	CARBON	IPt	1 MI OFF HELT RD ON STOCKMAN TRAIL; SOFT VF GRND QTZ SS, LARGE XBEDS, PEA-SIZED NODULES; 20-25' ABOVE B57-1; TOTAL OC 100' THICK; 15-20' DUNE PACKAGES CAPPED BY 10-15' THICK CALCAREOUS TABULAR SS	100	9999	Tensleep		719.1	347.1	70/140	fail	0.642	0.662						Yes	yes
B57-3	45.09057	-108.57377	NAV-	WGS84	5151	08S	26E	32	CC	CARBON	IPt	1 MI OFF HELT RD ON STOCKMAN TRAIL; 20' UP SECTION FROM B57-2; MASSIVELY BEDDED QTZ SS JUST ABOVE XBEDS, BELOW LIMEY CAP ROCK; TOTAL OC 100' THICK; 15-20' DUNE PACKAGES CAPPED BY 10-15' THICK CALCAREOUS TABULAR SS	100	9999	Tensleep		-	700.6	70/140	fail	0.650	0.666	15.1	18.1				yes	no
B58-1	45.05942	-108.45475	NAV-	WGS84	5496	09S	27E	18	AA	CARBON	IPt	HAIRPIN TURNS ON HELT RD (BLM1016) ABOUT 1/2 MI W OF RED PRYOR MTN RD ; NODULAR, FRIABLE, VF GRND QTZ SS; NODULES PEA TO MARBLE SIZE, MASSIVE BEDDING; 10-15' ABOVE AMSDEN CONTACT	15	9999	Tensleep		452.1	424.9	70/140	Fail	0.637	0.663						Yes	Yes
B58-2	45.05942	-108.45508	NAV-	WGS84	5496	09S	27E	18	AA	CARBON	IPt	HAIRPIN TURNS ON HELT RD (BLM1016) ABOUT 1/2 MI W OF RED PRYOR MTN RD ; MASSIVELY BEDDED QTZ SS - WEATHERS TO "ROUNDED BOULDERS" IN OUTCROP; 40' ABOVE AMSDEN CONTACT	15	9999	Tensleep		407.5	389.7	70/140	fail	0.636	0.601	12.6	10.7				Yes	yes
B59-1	45.03587	-108.43668	NAV-	WGS84	5181	09S	27E	20	DA	CARBON	IPt	HELT RD 2 MI N OF CROOKED CK INTERSECTION ; WHITE FRIABLE VF GRND SS	10	9999	Tensleep		416.4	310.8	70/140	fail	0.660	0.647	20.2	22.2				Yes	No
B59-2	45.03137	-108.43388	NAV-	WGS84	5105	09S	27E	20	DD	CARBON	IPt	HELT RD 1 1/2 MI N OF CROOKED CK INTERSECTION ; WHITE FRIABLE VF GRND SS	10	9999	Tensleep		422.1	220.6	70/140	fail								YES	YES
B59-3	45.02473	-108.43287	NAV-	WGS84	5007	09S	27E	28	BC	CARBON	IPt	HELT RD 1 MI N OF CROOKED CK INTERSECTION ; WHITE FRIABLE VF GRND SS; MASSIVE BEDDING W/ LARGE-SCALE XBEDS	10	9999	Tensleep		450.9	260	70/140	Fail								yes	yes
B60-1	45.03252	-108.36217	NAV-	WGS84	4635	09S	27E	24	DC	CARBON	IPt	N ON OLD CROOKED CK; 1 MI NE ON BURNT TIMBER - TILLET RIDGE RD; WHITE FRIABLE VF GRND SS	20	9999	Tensleep		289.5	132.3	70/140	pass	0.643	0.648	8.8	14.6				Yes	No
B60-2	45.03353	-108.36203	NAV-	WGS84	4665	09S	27E	24	DC	CARBON	IPt	N ON OLD CROOKED CK; 1 MI NE ON BURNT TIMBER - TILLET RIDGE RD; WHITE FRIABLE VF GRND SS; VERY SOFT, RED STAINING; 400' N OF B60-1	20	9999	Tensleep		285.8	120.2	70/140	Fail	0.644	0.660	10.9	14.1				Yes	No
B60-3	45.03477	-108.36182	NAV-	WGS84	4708	09S	27E	24	DC	CARBON	IPt	N ON OLD CROOKED CK; 1 MI NE ON BURNT TIMBER - TILLET RIDGE RD; WHITE FRIABLE VF GRND SS; MASSIVE BEDDING ; 400' N OF B60-2	20	9999	Tensleep		656.7	626.4	70/140	Fail	0.669	0.654						YES	Yes
B61-2	46.95128	-109.53411	NAV-	WGS84	4355	14N	17E	26	BA	FERGUS	Kk	NE SIDE OF BEAVER CK RD; 150 YDS SOUTH OF INTERSECTION WITH FARREN HILL RD; YELLOWISH FINE-MED GRND QTZ ARENITE; XBEDDED, POOR TO MOD SORTING	8	50	Kootenai		250.9	205.2	40/70	Fail	0.643	0.607						No	No
B62-1	46.91205	-109.4917	NAV-	WGS84	4672	13N	18E	6	CD	FERGUS	IPM	W SIDE OF BEAVER CK RD; APPROX 4 MI SOUTH OF FARREN HILL INTERSECTION; YELLOWISH FINE-MED GRND QTZ SS; MOST HIDDEN BENEATH COVER	5	50	Tyler		1298	1169	40/70	pass	0.647	0.696	8.7					yes	no
B62-2	46.90677	-109.49048	NAV-	WGS84	4701	13N	18E	7	AB	FERGUS	IPM	W SIDE OF BEAVER CK RD; APPROX 4 MI SOUTH OF FARREN HILL INTERSECTION; MASSIVE BEDDING, YELLOWISH F-MED GRND QTZ SS, FRIABLE IN LOWER SECTION. THINNER BEDS ABOVE; 300 YDS SO OF B62-1	15	300	Tyler		826.4	796.8	40/70	fail	0.651	0.668	15.3					YES	NO
B62-3	46.90927	-109.49102	NAV-	WGS84	4731	13N	18E	7	AB	FERGUS	IPM	W SIDE OF BEAVER CK RD; APPROX 4 MI SOUTH OF FARREN HILL INTERSECTION; MASSIVE BEDDING, YELLOW-WHITE FINE GRND QTZ SAND; 200 YDS SO OF B62-1; MOST OC HIDDEN BENEATH COVER	5	50	Tyler		1376.9		70/140	pass	0.625	0.647	5.6					YES	NO
B63-1	46.60878	-110.50172	NAV-	WGS84	5656	10N	10E	20	CC	MEAGHE	_f	N ON SPRING CK RD (FS274); SW OF INTERSECTION W/ 15810; HARD, INDURATED QTZITE; POOR SAMPLE	15	9999	Flathead		474.9	326.9	40/70	fail	0.619	0.540						Yes	No
B63-2	46.67213	-110.49953	NAV-	WGS84	6195	11N	10E	32	BD	MEAGHE	_f	W. SIDE SPRING CK RD - ABOUT 3/4 MI SOUTH OF WHITETAIL CAMP ; REDDISH QTZ SS; MED GRND, SUBROUNDED, MOD SORTED; COVERED	5	50	Flathead		779.6	734.4	40/60	fail	0.648	0.671	20.8	22.4				Yes	No
B63-3	46.68257	-110.49058	NAV-	WGS84	6424	11N	10E	29	DB	MEAGHE	_f	SO. SIDE SPRING CK RD - ABOUT 1/2 MI EAST OF WHITETAIL CAMP ; MED GRND QTZ SS; STAINED REDDISH-BROWN QTZ GRAINS (HEMATITE?)	8	75	Flathead		532.5	512	30/50	fail	0.646	0.561	20.8	24.3				Yes	No
B63-4	46.68257	-110.49058	NAV-	WGS84	6424	11N	10E	29	DB	MEAGHE	_f	SO. SIDE SPRING CK RD - ABOUT 1/2 MI EAST OF WHITETAIL CAMP ; MED-COARSE YELLOW QTZ SS, 1-2' BELOW B63-3, MUCH MORE FRIABLE	8	75	Flathead		751.3	744.6	30/50	pass	0.658	0.597	9.4	11.3				Yes	No
B63-5	46.68257	-110.49058	NAV-	WGS84	6424	11N	10E	29	DB	MEAGHE	_f	SO. SIDE SPRING CK RD - ABOUT 1/2 MI EAST OF WHITETAIL CAMP ; MED-COARSE RED FRIABLE QTZ SS, IRON STAINING	8	75	Flathead		794.4	790.3	40/70	pass	0.647	0.664	7.3	11.7				Yes	No

Sample Name	Latitude	Longitude	Geomethod	Datum	Elev	TWN	RNG	Sec	Qsec	County	Geo Symbol	Sampler Notes	Thick (ft)	Extent (ft)	Form'n Name	Member	Pre Wash	Post Wash	Tested Mesh Size	P/F	Spher	Roundness	Percent Fines 5K psi	6K psi	7K psi	8K psi	9K psi	>90% Silica	Clusters
B64-1	46.85333	-110.27463	NAV-	WGS84	4990	13N	11E	25	CD	JUDITH B	Mk	INTERSECTION SOUTH FORK & MIDDLE FORK RDS; 1 MI NE OF JUDITH RANGER STN; 1-2' THICK FINE-GRND QTZ SS, CALCITE CMT, 6-8" SPACED JOINTS, OC IS MOSTLY REDDISH MUDSTONE; ONLY SOME SANDY BEDS, OTHERWISE SILTS	2	150	Kibbey		1114.4	925.5	70/140	FAIL									Yes	Yes
B64-2	46.88512	-110.294	NAV-	WGS84	5095	13N	11E	14	CA	JUDITH B	Mk	2 MI WEST OF SAPPHIRE VILLAGE ON YOGO CK RD. (1/2 MI PAST WMA HDQS); WELL SORTED FINE GRND QTZ SAND, WELL ROUNDED GRAINS; FRIABLE	2	30	Kibbey		1390.8	1087.8	70/140	pass	0.665	0.680		9.5	12.7			Yes	No
B65-1	47.02683	-110.28635	NAV-	WGS84	4983	15N	11E	26	DD	JUDITH B	*q	LEHIGH RD SW OF WINDHAM; ENTER WILLOW CK CANYON FROM NE; WHITE, HARD VF GRND SS. MOST OF OC IS GRAY LIMESTONE (AMSDEN?); LOOKS VERY SIMILAR TO TENSLEEP			Quadrant		635	500.8	70/140	fail	0.697	0.692	15.1	18.7				Yes	No
B65-2	47.02122	-110.29023	NAV-	WGS84	5019	15N	11E	35	AB	JUDITH B	*q	LEHIGH RD SW OF WINDHAM; ENTER WILLOW CK CANYON FROM NE; WITHIN AMSDEN LS? - WHITE VF -F GRND QTZ SS, POORLY SORTED ; 1/2 MI SO. OF 65-1	4	15	Quadrant		559.7	339.1	70/140	fail	0.678	0.717	11.7	14.5				Yes	No
B65-3	47.00885	-110.2999	NAV-	WGS84	5167	14N	11E	2	BB	JUDITH B	IPM	1/4 N OF INTERSECTION WITH WOODHURST RD; TYLER SANDS OC IN AT LEAST TWO WELL-EXPOSED DIPPING PACKAGES, 15-20' THICK EACH; OPEN GATE, CROSS FIELD TO W	15	9999	Tyler		551.6	462.9	70/140	pass	0.626	0.644		8.2	10.6			Yes	No
B65-4	47.01052	-110.33862	NAV-	WGS84	5384	14N	11E	33	BA	JUDITH B	Mk	WOODHURST RD 1 MI EAST OF RUNNING WOLF CK; YELLOW, HARD, VF GRND QTZ SS, THIN BEDDING 1-2" THICK; BEDS STRIKE 50 DEG, DIP 17 DEG NW	10	50	Kibbey		584.5	339.2	16/30	fail								Yes	Yes
B65-5	47.05958	-110.31028	NAV-	WGS84	4898	15N	11E	15	DB	JUDITH B	IPM	RUNNING WOLF RD 3.5 MI S OF COUNTY RD 101; POOR OC; YELLOW BANDED FINE-MED GRND QTZ SS; IRON-STAINED?; SCATTERED, COVERED OUTCROP			Tyler		727	649	40/70	fail	0.683	0.602	21.1	24.9				Yes	No
B65-6	47.07852	-110.30725	NAV-	WGS84	4852	15N	11E	10	AD	JUDITH B	Jm	RUNNING WOLF RD 2 MI S OF COUNTY RD 101; THIN-BEDDED FLAGGY YELLOW SS, XBEDDED, SUBANGULAR GRAINS W/ LOTS OF LITHICS & CHERT	10	50	Morrison		229.6	140.6	20/40	fail								No	YES
B66-1	46.85882	-109.06102	NAV-	WGS84	4659	13N	21E	28	AC	FERGUS	IPM	3.5 MI WEST OF SURENOUGH-FLATWILLOW INTERSECTION; FINE-MED GRND QTZ SAND; FRIABLE; THIN TO MASSIVE BEDDING; BEHIND THE SHED	15	300	Tyler		819.1	718.6	40/70	pass	0.616	0.626	9.3	10.0	21.3			Yes	No
B66-2	46.8576	-109.03153	NAV-	WGS84	4642	13N	21E	26	CB	FERGUS	IPM	2.0 MI WEST OF SURENOUGH-FLATWILLOW INTERSECTION; FINE-MED GRND, RED-BR TYLER QTZ SS; HEMATITE?; SCATTERED, COVERED OUTCROP			Tyler		419.1	389.3	40/70	fail	0.626	0.639	27.1	32.2				Yes	No
B66-3	46.86028	-109.00408	NAV-	WGS84	4508	13N	21E	25	BD	FERGUS	IPM	1/2 MI WEST OF SURENOUGH-FLATWILLOW INTERSECTION; WHITE VF-F GRND FRIABLE QTZ SS	12	40	Tyler		872.9	468.6	70/140	pass	0.627	0.683	8.1	10.6				Yes	No
B67-1	46.82002	-108.99008	NAV-	WGS84	4547	12N	22E	7	AA	FERGUS	IPM	SOUTH FORK RD - 1MI WEST AFTER ROAD DROPS TO CREEK LEVEL; FINE-GRND QTZ SS NORTH SIDE OF ROAD	40	1000	Tyler		1001.6	935.7	70/140	pass	0.644	0.673		4.8	7.1	8.5	10.1	Yes	No
B67-2	46.82427	-108.97627	NAV-	WGS84	4485	12N	22E	5	DC	FERGUS	IPM	SOUTH FORK RD WHERE ROAD VEERS W AND DROPS DOWN TOWARD CREEK BOTTOM; MIX OF LITHOLOGIES, CONGL, LS, SHALE, SS; MUNDT TYPE SECTION?, SAMPLED VF-F GRND YELLOW FRIABLE QTZ SAND; MUNDT TYPE SECTION	20	500	Tyler		546	521.5	70/140	fail	0.641	0.637	11.9	12.3				Yes	No
BELT-01-SV-13	47.39065	-110.91709	NAV-	WGS84	3753	19N	06E	23	DD	CASCADE	Kks	ORR RD E OF BELT; ROAD CUT; QUARTZOSE, A LOT OF LIMONITE; ~10 FT EXPOSED, THIN IN COULEE WALLS THROUGHOUT BELT AREA	~10		Kootenai	Sunburst	-	-	70/140	fail	0.690	0.615	32.9	36.9				YES	YES
BELT-02-SV-14	47.384315	-110.945052	NAV-	NAD83	3823	19N	06E	27	AA	CASCADE	Kks	road down to Belt from highway 87			Kootenai	Sunburst	704.4	653.1	70/140	fail	0.645	0.529						Yes	No
BELT-03-SV-14	47.278158	-110.722003	NAV-	NAD83	4199	18N	08E	33	BC	CASCADE	Kks	road north of Raynesford, First Ave. E in town			Kootenai	Sunburst	645.8	326	20/40	fail								No	yes
BELT-04-SV-14	47.27459	-110.682822	NAV-	NAD83	4139	18N	08E	34	DD	CASCADE	Kks	Williams Creek Rd., west of Spion Kop			Kootenai	Sunburst	806.6	378.6	16/30	fail								YES	yes
BELT-05-SV-14	47.226564	-110.624848	NAV-	NAD83	4432	17N	09E	19	AB	CASCADE	Kks	Along Otter Creek Rd in excavated area			Kootenai	Sunburst	807.9	222.8	20/40	fail								Yes	Yes
BELT-06-SV-14	47.174867	-110.740369	NAV-	NAD83	4599	16N	08E	5	DB	CASCADE	Mk	Along Kibbey Grade Rd w of Otter Creek Rd; thin lenses encased in red mudstone.			Kibbey		277.4	157.3	20/40	fail								Yes	Yes
BELT-07-SV-14	47.161235	-110.838499	NAV-	NAD83	5036	16N	09E	7	DA	CASCADE	Mk	Roadcut along hwy 89; lenses no more than 4 ft long in red mudstone			Kibbey		362.4	159.4	20/40	fail								Yes	yes
BELT-08-SV-14	47.210207	-110.928606	NAV-	NAD83	4246	17N	06E	26	BA	CASCADE	Mk	Roadcut hwy 89 across from Sluiceboxes S.P. overlook; more ss in Mk here than previous localities but still in lenses w/in red mudstone			Kibbey		463.1	153.4	20/40	fail								Yes	Yes
BELT-09-SV-14	47.36757	-110.98425	NAV-	NAD83	3868	19N	06E	32	AA	CASCADE	Kks	Along McCoy Rd sw of Belt. e of Box Elder Creek; Hillside ss rubble, poor exposure			Kootenai	Sunburst	-	454.8	40/70	fail	0.657	0.575	15.1	19.4				Yes	No
BELT-11-SV-14	47.33757	-110.896818	NAV-	NAD83	3880	18N	06E	12	AC	CASCADE	Kks	New rd s of Armington off of rd e of Belt Cr and s of hwy; Kks lens sampled, overlying bed too f gr			Kootenai	Sunburst	587.8	499	30/50	Fail								No	Yes
BELT-12-SV-14	47.35118	-110.907383	NAV-	NAD83	3809	18N	06E	1	BA	CASCADE	Kks	Along Neil Creek Rd w of hwy 89; ss rubble along rd			Kootenai	Sunburst	-	631.6	40/70	fail	0.651	0.578	17.3	22.1				Yes	No
BELT-13-SV-14	47.027053	-110.819094	NAV-	WGS84	5550	15N	07E	27	DB	CASCADE	_f	ALONG BELT PARK RD, LOOSE VERY LARGE BLOCKS, EXTENSIVE IN BELT PARK, BUT OC ONLY ALONG DRAINAGES	~50		Flathead		663	624.4	30/50	fail	0.661	0.585	11.3	11.5				Yes	No
BELT-14-SV-14	47.007284	-110.81401	NAV-	WGS84	5923	14N	07E	3	AA	CASCADE	_f	ALONG BELT PARK RD, INDETERMINATE THICKNESS; SMALL BLOCKS AND RUBBLE, EXTENSIVE IN BELT PARK, BUT MUCH SOIL ON BENCH TOPS			Flathead		-	458.3	40/70	fail								Yes	yes
BZ-01-SV-14	45.879354	-111.894177	NAV-	WGS84	5268	02N	02W	31	DB	JEFFERSO	_f	COTTONWOOD CANYON RD OFF CARDWELL EXIT, I-90, VERTICAL AT ROAD CUT; EXTENSIVE IN AREA	~45		Flathead		472.3	407.3	40/70	fail	0.605	0.475						Yes	No
C-01	45.72358	-112.7654	NAV-	NAD83	6910	01S	09W	30		SILVER BO	*q	REACTS TO ACID; FORMATION EXPOSED; ON SHOOTING PERSERVE	2		Quadrant		-	-	16/30	fail								No	Yes
C-02	45.72359	-112.76538	NAV-	NAD83	6910	01S	09W	30		SILVER BO	*q	FORMATION EXPOSED; ON SHOOTING PRESERVE; REACTS TO ACID	2		Quadrant		-	-	16/30	fail								No	Yes
C-03	45.7236	-112.7637	NAV-	NAD83	6910	01S	09W	30		SILVER BO	*q	ON SHOOTING PRESERVE; FORMATION EXPOSED;REACTS TO ACID	2		Quadrant		-	-	20/40	fail								No	No

Sample Name	Latitude	Longitude	Geomethod	Datum	Elev	TWN	RNG	Sec	Qse	County	Geo Symbol	Sampler Notes	Thick (ft)	Extent (ft)	Form'n Name	Member	Pre Wash	Post Wash	Tested Mesh Size	P/F	Spher	Roundness	Percent Fines 5K psi	6K psi	7K psi	8K psi	9K psi	>90% Silica	Clusters
C-04	45.7236	-112.76537	NAV-	NAD83	6910	01S	09W	30		SILVER BO	*q	FORMATION EXPOSED; ON SHOOTING PERSERVE; REACTS TO ACID	2		Quadrant		-	-	20/40	fail								No	Yes
C-05	45.72368	-112.77024	NAV-	NAD83		01S	09W	30		SILVER BO	*q	REACTS TO ACID; ON SHOOTING PERSERVE			Quadrant		-	-	16/30	fail								No	Yes
C-06	45.76386	-112.71503	NAV-	NAD83	5750	01S	09W	9		SILVER BO	*q	FORMATION EXPOSED; REACTS TO ACID	6		Quadrant		-	427.6	16/30	fail								No	Yes
C-07	45.76388	-112.71502	NAV-	NAD83	5750	01S	09W	9		SILVER BO	*q	FORMATION EXPOSED; REACTS TO ACID	6		Quadrant		512.2	454.1	16/30	fail								Yes	Yes
C-08	45.55293	-112.47298	NAV-	NAD83	5462	03S	07W	28		BEAVERH	*q	DOES NOT REACT TO ACID			Quadrant		1133.9	1084.8	40/70	fail								Yes	Yes
C-09	45.43804	-112.52966	NAV-	NAD83	4852	04S	08W	36		BEAVERH	*q	REACTS TO ACID			Quadrant		966.2	737	70/140	fail	0.641	0.556	36.3	28.9				Yes	No
C-10	45.38666	-112.59911	NAV-	NAD83	5170	05S	08W	21		BEAVERH	*q	EXPOSED 2-5 FT, SLIGHT REACTION TO ACID			Quadrant		1161.8	964.1	40/70	fail	0.628	0.538	18.3	13.6				Yes	No
C-11	45.38774	-112.59982	NAV-	NAD83	5185	05S	08W	21		BEAVERH	*q	REACTS TO ACID			Quadrant		1197.8	1085.5	40/70	fail								No	Yes
C-12	45.88603	-112.67204	NAV-	NAD83	5825	02N	09W	26		SILVER BO	*q	SLIGHT REACTION TO ACID			Quadrant		1711.8	1637.6	16/30	fail								No	Yes
C71-1	46.6865	-109.16312	NAV-	NAD83	5092	11N	20E	26	AC	Golden V	Mk	yellow/orange calcareous qtz-rich silty sand, rippled, Fine grained (Lower 0.125-0.177mm), subangular	6	50	Kibbey		717.3	679.1	70/140	fail	0.637	0.661	12.4	14.9				YES	YES
C72-1	45.21597	-108.54368	NAV-	NAD83	5998	07S	26E	20	AA	Big Horn	Ipt	vf-f grnd white quartz ss, well-sorted, Subrounded, friable, Very well Sorted	60	750	Tensleep		488.4	399.9	70/140	Fail	0.633	0.658	21.9					yes	yes
C73-1	47.17187	-110.45433	NAV-	NAD83	4780	16N	10E	4	DD	Judith Ba	IPMt	Reddish cross-bedded medium grained (Lower 0.250-0.350mm) qtz ss, Friable, Rounded, Well Sorted	60	12000	Tyler		770.9	624.1	70/140	pass	0.640	0.667		5.7	4.4			yes	no
C73-2	47.17197	-110.45218	NAV-	NAD83	4869	16N	10E	3	CC	Judith Ba	IPMt	Reddish cross-bedded Medium Grained (Lower 0.250-0.350mm) qtz ss,Friable, Rounded, Moderately Sorted; hematite cmt	60	12000	Tyler		554	542	70/140	pass	0.634	0.680	6.9					YES	NO
C74-1	47.11735	-110.53183	NAV-	NAD83	5190	16N	09E	25	CA	Judith Ba	Mk	yellow limey very fine-fine (Lower F- Upper VF- 0.088-0.250mm) graind ss, Subrounded, moderatley sorted			Kibbey		644.4	345.4	40/70	fail								No	Yes
C75-1	47.15323	-110.36548	NAV-	NAD83	4622	16N	11E	28	CC	Judith Ba	Kk	salt & pepper med-coarse (0.710-0.250mm) grained chert & qtz ss; 1-4" flaggy bedding, Poorly Sorted, Subangular	15	50	Kootenai		560.9	523.6	40/70	fail	0.650	0.586	11.4					yes	no
C76-1	47.15337	-110.37785	NAV-	NAD83	4567	16N	11E	18	AB	Judith Ba	IPMt	friable, very well sorted, hematite cmt?	25	5000	Tyler		689.2	671.5	70/140	pass	0.639	0.679		9.2	10.5			yes	no
C77-1	47.02721	-110.34262	NAV-	NAD83	5334	15N	11E	28	CC	Judith Ba	IPMt	to subrounded, well sorted, friable	20	400	Tyler		610	559.4	70/140	pass	0.640	0.657	8.6					yes	no
C77-2	47.02729	-110.34235	NAV-	NAD83	5334	15N	11E	28	CC	Judith Ba	IPMt	yellow ferruginous banded & xbedded ss, Fine(Upper)-Medium(Lower- 0.088-0.350mm), subrounded, very well sorted, friable	20	400	Tyler		587.6	577	70/140	pass	0.636	0.667	6.6					yes	no
C77-3	47.03485	-110.32383	NAV-	NAD83	5049	15N	11E	27	BC	Judith Ba	IPMt	sorted	10	100	Tyler		440.1	400.9	70/140	pass	0.630	0.665	4.4					yes	no
C78-1	47.0708	-110.41455	NAV-	NAD83	5160	15N	10E	11	DC	Judith Ba	Mk	Fine(Upper-Lower 0.250-0.125mm) grained yellow qtz ss, Calcite Cement, Subrounded, mod sorted, hard	3	300	Kibbey		556.8	396.3	16/30	fail								yes	yes
C79-1	46.96497	-110.28205	NAV-	NAD83	5324	14N	11E	24	BB	Judith Ba	Mk	Medium-Fine grained yellow calcareous qtz ss, not very friable, Calcite cement, subangular, well sorted	2	100	Kibbey		454.1	385.9	70/140	fail	0.656	0.666	13.0					Yes	No
C80-1	46.96618	-110.2544	NAV-	NAD83	5154	14N	12E	19	BA	Judith Ba	IPMt	Fine grained well sorted qtz sand, subrounded, hand sample quite hard for no calcite cmt	30	9999	Tyler		364.4	374.8	70/140	pass	0.629	0.679	3.9					YES	NO
C81-1	46.81455	-110.12078	NAV-	NAD83	5880	12N	13E	8	BC	Judith Ba	Kk	yellow friable SS; rounded Medium grained qtz and black chert, well sorted	8	200	Kootenai		567.3	573.8	40/70	pass	0.670	0.619	7.2					Yes	No
C82-1	46.82038	-110.1416	NAV-	NAD83	5555	12N	13E	7	BB	Judith Ba	*q	base of 60' oc, vf grnd clean white qtz ss; 2-10" thick beds, xbedded	60	2000	Quadrant		409.3	396.9	70/140	fail	0.639	0.662	14.0	15.4				Yes	no
C82-2	46.82038	-110.1416	NAV-	NAD83	5565	12N	13E	7	BB	Judith Ba	*q	10' up section from 82-1, massive beded,White very friable vf-f grained qtz ss, Rounded, very well sorted	60	2000	Quadrant		658.3	627.4	70/140	pass	0.639	0.664		6.4	12.3			yes	no
C82-3	46.82038	-110.1416	NAV-	NAD83	5595	12N	13E	7	BB	Judith Ba	*q	40' up section from 82-1, 2-4" thin-bedded qtz ss, vf-f grained ss, Rounded, Very Well Sorted	60	2000	Quadrant		653.5	633.5	70/140	pass	0.628	0.649		8.8				YES	NO
C83-1	46.80295	-110.1664	NAV-	NAD83	5607	12N	12E	14	AA	Judith Ba	*q	yellow/orange limey qtzitic ss, 2-5" flaggy beds, subrounded grns, mod sorted	8	25	Quadrant		754.9	660.3	70/140	fail	0.661	0.680	22.1					Yes	No
C84-1	46.80445	-110.15912	NAV-	NAD83	5847	12N	12E	13	BB	Judith Ba	*q	white Fine grained qtz ss, subrounded, well sorted.	5	50	Quadrant		848.5	672.1	70/140	pass	0.626	0.656	6.0					Yes	No
C85-1	46.81047	-110.12305	NAV-	NAD83	5844	12N	13E	8	CB	Judith Ba	*q	white, massive & xbedded Fine grained qtz ss, Well sorted, subrounded	20	750	Quadrant		406.4	385.1	70/140	pass	0.644	0.682	6.4					Yes	No
C85-2	46.81047	-110.12305	NAV-	NAD83	5858	12N	13E	8	CB	Judith Ba	*q	orange/yellow flaggy qtz ss Fine-Very Fine, Rounded, Moderately Sorted	10	750	Quadrant		-	190.7	70/140	fail								YES	YES
C92-1	46.79833	-109.20798	NAV-	NAD83	6014	12N	20E	16	DB	Fergus	IPMt	dark red-brown hematite-cmt med-grained qtz ss; very friable, well sorted, well rounded	10	100	Tyler		402.6	399.2	40/70	fail	0.633	0.659	15.9					Yes	NO
C92-2	46.79833	-109.20798	NAV-	NAD83	6026	12N	20E	16	DB	Fergus	IPMt	yellowish-red med grained qtz ss; 10' above 92-1; ferruginous banding common, Very Friable, Well Sorted, well Rounded	10	100	Tyler		354.4	332.8	40/70	fail	0.632	0.630	12.8					yes	no
CFD-01-SV-14	46.802279	-111.835682	NAV-	NAD83	3948	12N	02W	15	AA	LEWIS AN	_f	EXTENSIVE BUT LIMITED ACCESS; ALONG BEAVER CR RD SE OF NELSON NEAR NELSON SCHOOL HOUSE	250	250	Flathead		713.7	542.4	30/50	fail	0.559	0.475	20.5	12.5				Yes	No
CFD-02-SV-14	46.786707	-111.897252	NAV-	NAD83	3623	12N	02W	19	DA	LEWIS AN	Mk	EXTENSIVE BUT LIMITED ACCESS; ALONG BEAVER CREEK RD NEAR MISSOURI R ACCESS	250	100	Kibbey		203.9	119.8	20/40	fail								Yes	Yes
CFD-03-SV-14	46.79651	-111.889159	NAV-	NAD83	3793	12N	02W	17	AC	LEWIS AN	Mk	AMERICAN GAR RD ALONG BIG LOG GULCH, W SIDE OF ROAD; FGN SS ON W SIDE OF RD. TOO TIGHTLY CEMENTED. TOO FINE GRAINED	250	250	Kibbey		346.6	245.6	16/30	fail								Yes	Yes
CFD-04-SV-14	46.81665	-111.912885	NAV-	NAD83	3974	12N	02W	7	BB	LEWIS AN	*q	ALONG AMERICAN BAR RD; EXTENSIVE BUT LIMITED	~300	~200	Quadrant		429.1	324.4	16/30	fail								Yes	yes
CFD-05-SV-14	46.82619	-111.779886	NAV-	NAD83	4228	12N	01W	6	AC	LEWIS AN	_f	BEAVER CRREK RD NEAR CHCKERBOARD GULCH; EXTENSIVE BUT LIMITED ACCESS	100	75	Flathead		558.3	435.9	16/30	fail								Yes	Yes
CFD-06-SV-14	46.708117	-111.785125	NAV-	NAD83	3861	11N	02W	13	AD	LEWIS AN	_f	EAST OF YORK BRIDGE, TROUT CREEK RD TO YORK; EXTENSIVE ALONG STRIKE	100	~100	Flathead		-	366	20/40	fail	0.525	0.360						Yes	yes
CFD-07-SV-14	46.86801	-111.695397	NAV-	NAD83	5344	13N	01W	23	AC	LEWIS AN	*q	BURNT GULCH RD BETWEEN BEAVER CREEK AND PIKE CREEK HAIRPIN CURVE; EXTENSIVE ALONG STIKE BUT LIMITED ACCESS	250	250	Quadrant		512.2	454.1	70/140	pass	0.669	0.628	10.0	14.0				Yes	No
CFD-08-SV-14	46.90974	-111.894582	NAV-	NAD83	4567	13N	02W	5	BC	LEWIS AN	Kks	ALONG WILLOW CREEK RD; WELL EXPOSED DIP SLOPE	~200	~200	Kootenai	Sunburst	450.7	313.5	70/140	fail	0.585	0.542						Yes	Yes

Sample Name	Latitude	Longitude	Geomethod	Datum	Elev	TWN	RNG	Sec	Qse	County	Geo Symbol	Sampler Notes	Thick (ft)	Extent (ft)	Form'n Name	Member	Pre Wash	Post Wash	Tested Mesh Size	P/F	Spher	Roundness	Percent Fines 5K psi	6K psi	7K psi	8K psi	9K psi	>90 % Silica	Clusters
CFD-09-SV-14	46.913318	-111.885129	NAV-	NAD83	4337	13N	02W	5	BC	LEWIS AN	*q	Along Willow Creek Rd; resistant ocs on both sides of rd; numerous large blocks below; short distance east of CFD-8. Je apparently very thin here	300	300	Quadrant		549.5	368.9	70/140	fail	0.618	0.552						Yes	No
CFD-10-SV-14	46.99446	-111.991971	NAV-	NAD83	3619	14N	03W	4	CD	LEWIS AN	Kblf	BEARTOOTH RD. NE SIDE HOLTER LAKE; THIN, BUT EXTENSIVE IN THIS AREA	50	50	Blackleaf	Flood	550.1	268.8	70/140	fail	0.557	0.500						Yes	No
CFD-11-SV-14	46.99506	-111.99845	NAV-	NAD83	3743	14N	03W	4	CC	LEWIS AN	Kblf	EXTENSIVE IN AREA EAST OF HOLTER LAKE	50	50	Blackleaf	Flood	416.5	341.1	16/30	fail								Yes	Yes
CFD-12-SV-14	46.690069	-111.296792	NAV-	WGS84	4933	11N	03E	25	AB	MEAGHE	_f	ALONG RD 287 BETWEEN CONFEDERATE GULCH AND FORT LOGAN, EXTENSIVE NEARLY VERTICAL RIDGE; SAMPLED FLOAT BELOW	~75		Flathead		703.5	243.2	40/70	fail								Yes	Yes
CFD-13-SV-14	46.72089	-111.280821	NAV-	WGS84	5032	12N	04E	7	CD	MEAGHE	_f	ALONG LINGSHIRE RD, THICKNESS INDETERMINATE, LARGE BLOCKS OF SS, NO OC APPARENT			Flathead		875.5		30/50	fail	0.629	0.547						Yes	No
CFD-14-SV-14	46.729779	-111.364408	NAV-	WGS84	5520	11N	03E	9	BD	MEAGHE	_f	ALONG UPPER MILLEGAN RD S OF WAGNER RD, LG SS BLOCKS IN EXTENSIVE BAND	~125		Flathead		666		16/30	fail								Yes	Yes
CFD-15-SV-14	46.841612	-111.404489	NAV-	WGS84	4960	13N	03E	31	CA	MEAGHE	Mk	ALONG UPPER MILLEGAN RD AT LINGSHIRE, OC AND BOULDERS BELOW	~50		Kibbey		596	292.6	40/70	fail								Yes	Yes
CFD-16-SV-14	46.856693	-111.366762	NAV-	WGS84	4658	13N	03E	28	CB	MEAGHE	Mk	ALONG NEW SEGMENT OF UPPER MILLEGAN RD BETWEEN LINGSHIRE AND MILLEGAN, OC AND ALREADY EXCAVATED SURFACE FOR NEW RD SEGMENT	~50		Kibbey		781.9	565.9	70/140	fail	0.612	0.368						Yes	No
CFD-17-SV-14	46.676566	-111.14091	NAV-	WGS84	4667	11N	05E	31	AA	MEAGHE	_f	ALONG HWY 360 AT SMITH RIVER, STEEPLY DIPPING OC; SOME IS TIGHTLY CEMENTED HERE	~100		Flathead		603.1	371.3	20/40	fail								Yes	Yes
CFD-18-SV-14	46.829335	-111.16383	NAV-	WGS84	4531	12N	04E	1	DA	MEAGHE	_f	ALONG SMITH RIVER RD JUST N OF ROCKING C'S RANCH ARCHWAY, RD CUTS UP THROUGH FLATHEAD OC; A LOT OF LIMONITE SPECKS HERE	~100		Flathead		637.8	441.1	70/140	pass	0.632	0.587		6.4	10.3			Yes	No
CHOT-1-SV-14	47.79595	-112.22916	NAV-	NAD83	7257	24N	05W	34	AB	TETON	Kvi	Burt Hill along Belleview Rd; sampled below titaniferous ss, too f gr, not quartzose			Virgelle		340	191.7	70/140	fail								Yes	Yes
DBR-01-SV-13	47.2536	-112.21975	NAV-	WGS84	4275	17N	05W	3	DB	LEWIS AN	Kvi	RD CUT ALONG WY 200 S OF AUCHARD CREEK; HIGHWAY CUT; LITTLE EXPOSURE IN HIGHWAY CUT; SOME BEDS QUARTZOSE + A LITTLE BL CHERT; OTHERS WITH TOO MUCH CHERT; 50 FT EXPOSED, EXTENDS ALONG AUCHARD CREEK ACC TO MAP	50		Virgelle		-	-	70/140	fail	0.640	0.588	45.5	51.3				Yes	No
DBR-02-SV-13	47.29582	-112.27107	NAV-	WGS84	4314	18N	05W	20	CA	LEWIS AN	Kvi	RD TO AUCHARD CREEK OFF OF BLACK ROCK RD; 2 FT EXPOSURE IN ROAD CUT; QUARTZOSE SS, EXTENDS ALONG AUCHARD CREEK (~6 MILES) ACC TO MAP	30		Virgelle		-	-	70/140	fail	0.633	0.575	28.3					Yes	No
DILL-01-SV-14	45.038492	-112.652151	NAV-	WGS84	6390	09S	09W	24	A	MADISON	*q	BLACKTAIL RANGE: EAST SIDE SHEEP CREEK CANYON, CONOVER RANCH AREA, PRIVATE LOGGING ROAD ACCESS; BLM LAND, THICKNESS ~700 FT, BUT SAMPLED SAND AND RUBBLE FROM ABOVE, LOOSE SAND AND VERY FRIABLE SS WITHIN LANDSLIDE DEPOSIT (NOT SHOWN ON TYSDAL MAP)	~700		Quadrant		-	413.7	70/140	fail	0.640	0.590	33.0	33.9				Yes	No
DILL-02-SV-14	45.030545	-112.649832	NAV-	WGS84	6643	09S	09W	24	DC	MADISON	*q	BLACKTAIL RANGE: EAST SIDE SHEEP CREEK CANYON, CONOVER RANCH, PRIVATE LOGGING ROAD ACCESS EAST OF "RYE GRASS MEADOW" (LANDOWNER NAME), THICKNESS ~700 FT BUT SAMPLED SAND AND RUBBLE FROM ABOVE, LOOSE SAND AND VERY FRIABLE SS WITHIN LANDSLIDE DEPOSIT; TEST PIT	~700		Quadrant		596.3	435.3	40/70	fail	0.654	0.627	32.8	33.8				Yes	No
DILL-03-SV-14	45.023159	-112.653849	NAV-	WGS84	6537	09S	09W	25	BD	MADISON	*q	BLACKTAIL RANGE: WEST SIDE SHEEP CREEK CANYON, CONOVER RANCH, PRIVATE LOGGING ROAD ACCESS; "COUGAR TREE" AREA (LANDOWNER NAME); TEST PIT, THICKNESS ~700 FT BUT SAMPLED SECONDARY SAND DEPOSIT; LOOSE SAND AND VERY FRIABLE SS; TEST PIT	~700		Quadrant		-	644.5	70/140	pass	0.659	0.682	5.7	10.4				Yes	No
DILL-04-SV-14	45.022889	-112.654638	NAV-	WGS84	6558	09S	09W	25	BD	MADISON	*q	BLACKTAIL RANGE: WEST SIDE SHEEP CREEK CANYON; CONOVER RANCH, PRIVATE LOGGING ROAD ACCESS; "COUGAR TREE" AREA (LANDOWNER NAME), THICKNESS ~700 FT, BUT SAMPLED BLOCK NOT IN OC, SS BLOCKS FROM CLIFF ABOVE	~700		Quadrant		533.7	466.8	40/70	fail	0.657	0.605	24.5	26.8	29.2			Yes	No
DILL-05-SV-14	45.022842	-112.642474	NAV-	WGS84	6866	09S	09W	25	AD	MADISON	*q	BLACKTAIL RANGE: EAST SIDE SHEEP CREEK CANYON; CONOVER RANCH, PRIVATE LOGGING ROAD ACCESS, THICKNESS ~700 FT, BUT SAMPLED BLOCK NOT IN OC, LOOSE BLOCKS FRIABLE SS	~700		Quadrant		639.1	-	70/140	fail	0.663	0.651	21.7	24.1				Yes	No
DILL-06-SV-14	45.022942	-112.646229	NAV-	WGS84	6869	09S	09W	25	AD	MADISON	*q	BLACKTAIL RANGE: EAST SIDE SHEEP CREEK CANYON; CONOVER RANCH, PRIVATE LOGGING ROAD ACCESS, THICKNESS ~700 FT, BUT SAMPLED BLOCK NOT IN OC, LARGE BLOCKS FRIABLE SS	~700		Quadrant		-	629.3	70/140	fail	0.674	0.473						Yes	No
DILL-07-SV-14	45.013463	-112.651204	NAV-	WGS84	6835	09S	09W	36	AB	MADISON	*q	BLACKTAIL RANGE: WEST SIDE SHEEP CREEK CANYON, CONOVER RANCH AREA, PRIVATE LOGGING ROAD ACCESS; STATE LAND, THICKNESS ~700 FT, BUT SAMPLED SECONDARY SAND DEPOSIT, LOOSE SAND FROM QUADRANT FM	~700		Quadrant		-	-	70/140	pass	0.639	0.654		5.5	6.6	12.2		Yes	No
DILL-08-SV-14	45.024181	-112.649685	NAV-	WGS84	6663	09S	09W	25	AC	MADISON	*q	BLACKTAIL RANGE: EAST SIDE SHEEP CREEK CANYON, CONOVER RANCH, PRIVATE LOGGING ROAD ACCESS, THICKNESS ~700 FT, BUT SAMPLED BLOCK NOT IN OC, LARGE BLOCKS FRIABLE SS WITHIN LANDSLIDE DEPOSIT (NOT SHOWN ON TYSDAL MAP	~700		Quadrant		697.3	544.4	70/140	pass	0.657	0.658		10.0	11.3			Yes	No
DNRC-TK-01	45.4042	-112.604	ADDI	WGS84		05S	08W	16		BEAVERH	Pp	HI SILICA CEMENTED, PINK, MEDIUM TO COARSE GRAIN SIZE, SEVERAL HUNDRED FT THICK			Phosphoria		-	-	-	fail								NO	-
DNRC-TK-02	45.4037	-112.6007	ADDI	WGS84		05S	08W	16		BEAVERH	Pp	HI SILICA CEMENTED, WHITE TO CREAM COLOR, VERY FINE GRAIN SIZE			Phosphoria		-	-	-	fail								NO	-
DNRC-TK-03	45.4021	-112.6002	ADDI	WGS84		05S	08W	16		BEAVERH	Pp	SILICA CEMENTATION, PINK & CREAM YELLOWISH BROWN BANDED/FOLDED, VERY FINE GRAINS, FOUND IN ROADWAY AT SODAK MINE	5-10		Phosphoria		-	-	-	fail								NO	-

Sample Name	Latitude	Longitude	Geomethod	Datum	Elev	TWN	RNG	Sec	Qse	County	Geo Symbol	Sampler Notes	Thick (ft)	Extent (ft)	Form'n Name	Member	Pre Wash	Post Wash	Tested Mesh Size	P/F	Spher	Roundness	Percent Fines 5K psi	6K psi	7K psi	8K psi	9K psi	>90 % Silica	Clusters
DNRC-TK-04	45.4078	-112.5914	ADDR	WGS84		05S	08W	16		BEAVERH	Pp	SILICA CEMENTATION, LIGHT GRAY, MEDIUM TO FINE GRAIN SIZE, DIDN'T SCRATCH WITH KNIFE	10-15		Phosphoria		-	-		fail									NO	-
ELL-01-SV-14	46.643492	-112.452655	NAV-	NAD83	5401	10N	07W	2	CC	POWELL	_f	CLARKS CANYON ROAD ALONG TROUT CREEK; EXTENSIVE BUT POORLY EXPOSED; PIECES OF ROCK	100	100	Flathead		497.4	312.1	16/30	fail									Yes	yes
ELL-02-SV-14	46.65562	-112.443654	NAV-	NAD83	5723	10N	07W	2	AB	POWELL	*q	EXTENSIVE BUT LIMITED ACCESS. TOO TIGHTLY CEMENTED	150	150	Quadrant		418.3	294.7	16/30	fail									Yes	yes
ELL-03-SV-14	46.996342	-112.010829	NAV-	NAD83	3487	14N	03W	5	AC	LEWIS AN	Kks	ROAD TO HOLTER DAM WEST OF MISSOURI; LIMITED TO EXPOSURE IN ANTICLINE ALONG ROAD	70	70	Kootenai	Sunburst	600.2	367.4	30/50	fail									Yes	yes
ELL-04-SV-14	46.599341	-112.788154	NAV-	NAD83	4808	10N	10W	9	DD	POWELL	Kblf	north on Warm Springs Rd between I-90 Phosphate and Garrison exits, access from frontage road			Blackleaf	Flood	430.1	233.8	16/30	fail									Yes	yes
ELL-05-SV-14	46.640332	-112.85371	NAV-	NAD83	5060	10N	10W	9	DD	POWELL	Kblf	Rd 16 n of Phosphate exit off I-90, then rd 184 along E Fk Brock Cr			Blackleaf	Flood	-	354.5	40/70	fail									Yes	yes
ENN-01-SV-14	45.117632	-111.881618	NAV-	WGS84	8206	08S	02W	20	CC	MADISON	Kt	GRAVELLY RANGE: ACROSS FROM CROCKETT LAKE ALONG DEVILS LANE BETWEEN CALL RD (292) AND PRIMITIVE RD 9676R, EXTENT INDETERMINATE, SAMPLED FLOAT BLOCK FROM ABOVE, BASAL KT SS (KBLF EQUIV)			Thermopolis		-	229.7	70/140	fail	0.652	0.392							Yes	No
ENN-02-SV-14	45.109117	-111.877328	NAV-	WGS84	8250	08S	02W	29	CA	MADISON	*q	GRAVELLY RANGE: ALONG DEVILS LANE PART OF RD 290, SE OF PRIMITIVE RD 9676R, EXTENT ~ 250 FT BUT ONLY LOOSE BLOCKS EXPOSED AT SURFACE, LOOSE BLOCKS IN MEADOW	~ 250		Quadrant		-	525.8	70/140	fail	0.646	0.434							Yes	No
ENN-03-SV-14	45.10773	-111.875792	NAV-	WGS84	8360	08S	02W	29	CA	MADISON	*q	GRAVELLY RANGE: ALONG DEVILS LANE DEVILS LANE PART OF RD 290, THICKNESS ~ 250 FT BUT ONLY LOOSE BLOCKS EXPOSED AT SURFACE, LOOSE BLOCKS IN MEADOW	~ 250		Quadrant		-	447.3	70/140	fail	0.646	0.427							Yes	No
ENN-04-SV-14	45.091799	-111.86168	NAV-	WGS84	8451	08S	02W	33	CB	MADISON	*q	GRAVELLY RANGE: ALONG DEVILS LANE DEVILS LANE PART OF RD 290, Tthickness ~ 250 FT BUT ONLY LOOSE BLOCKS EXPOSED AT SURFACE, LOOSE BLOCKS FROM LOCAL OC	~ 250		Quadrant		-	509.2	70/140	pass	0.653	0.627		8.1	12.4				Yes	No
ENN-05-SV-14	45.068686	-111.867689	NAV-	WGS84	8400	09S	02W	8	AA	MADISON	Psh	GRAVELLY RANGE: ALONG DEVILS LANE DEVILS LANE PART OF RD 290, TALUS-COVERED HILL	~200		Shedhorn		601.5	464.2	70/140	pass	0.648	0.627		10.0	13.2				Yes	No
ENN-06-SV-14	45.075214	-111.867518	NAV-	WGS84	8453	09S	02W	5	DC	MADISON	Psh	GRAVELLY RANGE: ALONG DEVILS LANE DEVILS LANE PART OF RD 290, TALUS-COVERED HILL	~200		Shedhorn		296.2	261.9	16/30	fail									Yes	yes
ENN-07-SV-14	45.090977	-111.862455	NAV-	WGS84	8465	08S	02W	32	DD	MADISON	*q	GRAVELLY RANGE: ALONG DEVILS LANE DEVILS LANE PART OF RD 290, THICKNESS ~ 250 FT, BUT ONLY LOOSE BLOCKS EXPOSED AT SURFACE, LOOSE BLOCKS IN MEADOW	~ 250		Quadrant		1340.9	182.6	70/140	pass	0.646	0.644		8.7					Yes	No
ENN-08-SV-14	45.114751	-111.893332	NAV-	WGS84	8247	08S	02W	30	BA	MADISON	*q	GRAVELLY RANGE: ALONG RD 290 N OF JUNCTION WITH CALL RD (RD 292),THICKNESS ~ 250 FT, BUT ONLY LOOSE BLOCKS EXPOSED AT SURFACE, LOOSE BLOCKS IN MEADOW	~ 250		Quadrant		779.3	553.3	70/140	pass	0.659	0.605		8.1	10.6				Yes	No
ENN-09-SV-14	45.123569	-111.877441	NAV-	WGS84	8177	08S	02W	19	BD	MADISON	Kt	GRAVELLY RANGE: ALONG PRIMITIVE RD 6209 R OFF OF DEVILS LANE, THICKNESS INDETERMINATE, FLOAT BLOCK			Thermopolis		248.5	120	70/140	fail	0.660	0.491							Yes	No
ENN-10-SV-14	45.014374	-111.856188	NAV-	WGS84	8819	09S	02W	29	BA	MADISON	Psh	GRAVELLY RANGE: ALONG DEVILS LANE PART OF RD 290, TALUS-COVERED HILL	~200		Shedhorn		795.3	231.1	20/40	fail	0.478	0.313							Yes	yes
ENN-11-SV-14	45.001246	-111.856647	NAV-	WGS84	9015	09S	02W	29	CD	MADISON	Psh	GRAVELLY RANGE: ALONG DEVILS LANE PART OF RD 290, TALUS-COVERED HILL	~200		Shedhorn		884.5	285.3	70/140	pass	0.657	0.642	6.9	10.5					Yes	No
ENN-12-SV-14	45.142177	-111.835388	NAV-	WGS84	7526	08S	02W	15	BA	MADISON	*q	ALONG CALL RD (RD 292), THICKNESS ~75 FT; OC ABOVE; SAMPLE FROM LOOSE SS BLOCK, OC BAND CROSSES RD; WIDENS TO N	~75		Quadrant		1565.6	332.39	40/70	fail	0.659	0.604	11.5	14.6					Yes	No
ENN-13-SV-14	45.053939	-111.27784	NAV-	WGS84	6902	09S	04E	18	AA	GALLATIN	Kt	ALONG WAPITI CR RD (RD 2522), OFF OF TAYLOR FORK RD W OF HWY 191 IN THE GALLATIN CANYON, NO OC ALONG RD, BUT SHOULD BE PRESENT IN EXTENSIVE DIP SLOPE AREA	~25		Thermopolis		-	280.3	70/140	fail									Yes	Yes
ENN-14-SV-14	45.21717	-111.268165	NAV-	WGS84	6248	07S	03E	17	CC	GALLATIN	Kt	ALONG BEAVER CREEK RD. OFF OF HWY 191 IN GALLATIN CANYON; ON PRIVATE SIDE OF LOCKED GATE, BUT ALSO ALONG CR WHERE IT WAS SAMPLED, LOOSE SS BLOCKS ALONG N SIDE OF RD OUTSIDE OF CLOSED-GATE AREA	~25		Thermopolis		515.8	390.8	70/140	pass	0.619	0.553	8.8	12.5					Yes	No
ENN-15-SV-14	45.241999	-111.334594	NAV-	WGS84	6413	07S	03E	10	AD	GALLATIN	Kt	ALONG SOUTH FORK GALLATIN RIVER, NEAR OUSEL FALLS OFF OF OUSEL FALLS RD., REPRESENTATIVE OF EXTENSIVE EXPOSURES IN YELLOW MULE AREA TO SOUTHB	~30		Thermopolis		708.6	553	70/140	fail	0.636	0.629	11.4	15.9					Yes	No
ENN-16-SV-14	45.286776	-111.379299	NAV-	WGS84	10652	06S	03E	29	AB	MADISON	Kt	ALONG HWY 64 BETWEEN BIG SKY VILLAGE AND BIG SKY RESORT, SAMPLED TO ESTABLISH REGIONAL CHARACTERISTICS; LOCALLY EXPOSED HERE	~25		Thermopolis		618.7	389.7	16/30	fail									Yes	Yes
FB-01-SV-14	47.52212	-110.343739	NAV-	NAD83	3660	20N	11E	4	BA	CHOUTEA	Kvi	Along Geyser-Geraldine Rd sw of Geraldine. s of Kingsbury Lake			Virgelle		358.6	229.7	40/70	fail	0.623	0.440							Yes	No
FB-02-SV-14	47.51308	-110.358524	NAV-	NAD83	3910	20N	11E	5	DA	CHOUTEA	Kvi	Along Geyser-Geraldine Rd; sampled white part; numerous dikes in area			Virgelle		-	107.7	40/70	fail	0.633	0.497							Yes	No
FB-03-SV-14	47.51031	-110.362703	NAV-	NAD83	3813	20N	11E	8	DA	CHOUTEA	Kvi	Excavated area along Geyser-Geraldine Rd; numerous dikes in area			Virgelle		389.7	235.3	70/140	fail	0.647	0.617	12.2	13.8					Yes	No
GFN-01-SV-13	47.56971	-111.12045	NAV-	NAD83		21N	05E	17	DC	CASCADE	Kks	N OF RYAN ISLAND NEAR RYAN DAM FENCE ALONG ROAD TO DAM; QUARTZOSE, DK YELL ORANGE 10 YR 6/6 & V PALE ORNGE 10 Y R 8/2 & V LT GR N8 W BROWN SPECKS 5 YR 4/4; F GR; ABSORBS WATER; GRAINS CAN BE SCRAPED LOOSE; GRAIN SIZE IS FINE AND SUBROUNDED; NO REACTION TO ACID; WELL EXPOSED; NEAR RYAN DAM, BUILDINGS TO DAM FENCE ALONG ROAD AND ON ISLAND	100		Kootenai	Sunburst	-	-	70/140	pass	0.653	0.657		9.3	12.9				Yes	No

Sample Name	Latitude	Longitude	Geomethod	Datum	Elev	TWN	RNG	Sec	Qsec	County	Geo Symbol	Sampler Notes	Thick (ft)	Extent (ft)	Form'n Name	Member	Pre Wash	Post Wash	Tested Mesh Size	P/F	Spher	Roundness	Percent Fines 5K psi	6K psi	7K psi	8K psi	9K psi	>90 % Silica	Clusters
GFN-02-SV-14	47.58339	-111.05811	NAV-	NAD83	2849	21N	05E	11	DA	CHOUTEA	Kks	below Morony Dam on east side of Missouri R, northeast of Great Falls private land			Kootenai	Sunburst	471.7	289.8	70/140	fail	0.650	0.592		58.0				Yes	YES
GFS-01-SV-13	47.42312	-111.29231	NAV-	NAD83	3387	19N	03E	1	DC	CASCADE	Kks	DUNE RD UNPAVED NEAR LARGE METAL BUILDING - LOOSE SLABS ALONG RD, OC'S NEARBY; QUARTZOSE, V LT GRAY N8 WITH M BR SPECKS 5YR 4/4; F GR; LIGHT CGREY WITH RUST-COLORED LIMONITE SPECS; EXPSOURE IS LOOSE ROCK ALONG ROAD OUT CROP NEARBY; CEMENTATION- ABSORBS WATER, DIFFICULT TO SCRATCH OFF , LOCAL EXPOSURE, BUT EXTENSIVE IN AREAGRAINS; GRAINS SIZE FINE GRAINED AND DIFFICULT TO SEE SHAPE; NO REACTION TO ACID, INDETERMINATE THICKNESS	IND		Kootenai	Sunburst	-	-	70/140	fail	0.668	0.644	12.3	13.3				Yes	No
GFS-02-SV-13	47.42799	-111.30505	NAV-	NAD83	3435	19N	03E	1	BC	CASCADE	Kk	DUNE RD-PAVED BELOW BLUE HOUSE; QUARTZOSE, GR ORANGE 10YR 7/4 & DK YEL ORANGE 10 YR 6/6; FINE GRAINED ; ABSORBS WATER ; NO REACTION TO ACID; GRAINS CAN BE SCRAPED LOOSE; EXPOSURE LIMITED, LIMITED TO IMMEDIATE AREA, BUT EXTENSIVE IN GENERAL AREA	~20		Kootenai		-	513	40/70	FAIL	0.649	0.529						Yes	No
GFS-03-SV-13	47.41254	-111.31773	NAV-	NAD83	3465	19N	03E	11	CA	CASCADE	Kks	BIG BEND ESTATES ROAD CUT- SHARP GRADE TO RIVER - GOOD EXPOSURES; QUARTZOSE SOME BL CHERT; V LIGHTT GRAY (N8) & PINKISH GRAY (5 YR 8/1); FINE GRAINED; POROUS; NO REACTION TO ACID, ~4-6 FT LENSES, LARGE LENSES IN AN EXTENSIVE ZONE WITH LENSES 40 FT THICK			Kootenai	Sunburst	-	-	70/140	pass	0.696	0.680		9.3	12.8			Yes	No
GFS-04-SV-13	47.45054	-111.23826	NAV-	NAD83	3388	20N	04E	28	CC	CASCADE	Kks	BOULDER FROM ABOVE ALONG RR TRACKS N OF FIELDS RD. BETW FISHER & GOON HILL RDS; QUARTZOSE; YELLOWISH GRAY WIHT FAINT RUSTY SPECS TO RUSTY BROWN; ROCK COLOR SHEET-V PALE ORANGE (10 YR 8/2) W GR ORANGE SPECKS (10 YR 7/4); MEDIUM GRAINED; POROUS- FRIABLE; NO REACTION TO ACID, EXTENDS FOR 1/2 MI AROUND HILL	50-80		Kootenai	Sunburst	-		70/140	pass	0.644	0.641		6.5	8.8	10.5		Yes	No
GFS-05-SV-13	47.43757	-111.26246	NAV-	NAD83	3463	20N	04E	32	CC	CASCADE	Kks	FISHER RD OFF FIELDS RD - ROADCUT GOING UP GRADE; QUARTZOSE, ROCK COLOR SHEET-V LT GRAY (N8) & YEL GR (5Y 8/1); MEDIUM GRAINED; POROUS- FRIABLE ; NO REACTION TO ACID, EXTENSIVE IN AREA	20-40		Kootenai	Sunburst	-		70/140	pass	0.638	0.651			9.9	12.5		Yes	No
GFS-06-SV-13	47.38551	-111.12422	NAV-	NAD83	3750	19N	05E	20	AC	CASCADE	Kks	E OF CENTERVILLE NEAR TOP OF SPRING VALLEY RD; QUARTZOSE INTERBED STRINGERS W BL CHERT + WT CLAY; ROCK COLOR CHART- V LT GR (N8)AND V PALE ORANGE (10 YR 8/2); LOWER MED & FINE GRAINED; POROUS; ROADCUT; NO REACTION TO ACID; QUARTZ-ROUNDED-SUBROUNDED; PURE QUARTZ GRAINS IN STRONGERS, EXTENSIVE IN AREA	~80		Kootenai	Sunburst	-		40/70	fail	0.647	0.533	28.2	33.0				Yes	No
GFS-07-SV-13	47.44667	-111.15008	NAV-	NAD83	3407	20N	05E	31	BD	CASCADE	Kks	STOCKETT RD NEW SEGMENT NEAR GERBER - JUST NORTH OF FRESH RD CUT ; QUARTZOSE WITH BLACK CHERT; ROCK COLOR CHART-VERY LIGHT GRAY (N8); FINE GRAINED; POROUS; CAN SCRAPE GRAINS LOOSE; WEATHERED EXPOSURE NORTH OF FRESH ROAD CUT; NO REACTION TO ACID, LIMITED TO ROADCUT AT BEND	~20		Kootenai	Sunburst	-	-	40/70	pass	0.678	0.571		6.8	8.3	11.4		Yes	No
GFS-08-SV-13	47.44549	-111.14774	NAV-	NAD83	3465	20N	05E	31	BD	CASCADE	Kks	STOCKETT RD NEW SEGMENT NEAR GERBER - FRESH PART OF ROADCUT; QUARTZOSE W BL CHERT, ROCK COLOR CHART-VERY PALE ORANGE (10 YR 8/2) WITH SOME MODERATE BROWN SPECS (5YR 4/4); FINE TO MEDIUM GRAINED; POROUS; CAN SCRAPE LOOSE GRAINS; GRAIN SHAPE- ANGULAR TO ROUNDED, QUARTZOSE & OTHER GRAINS OTHER SHAPES; EXPOSED IN ROADCUT; UNIT- SS BEDS BETWEEN SILTY MUDSTONE BEDS; NO REACTION TO ACID, EXTENT ONLY TO ROAD CUT	~40		Kootenai	Sunburst	-		70/140	fail	0.674	0.648	11.1	14.3				Yes	No
GFS-09-SV-13	47.45363	-111.19921	NAV-	NAD83	3411	20N	04E	27	DD	CASCADE	Kks	TRAPPER VALLEY RD OFF OF GERBER ROAD BEFORE HOUSES - OC ALONG RD; S & P SS; ROCK COLOR CHART-VERY LIGHT GRAY (N8), FINE GRAINED- NOT PURE QUARTZ; POROUS ; GRAINS CAN BE SCRAPPED LOOSE; NO REACTION TO ACID, EXTENT ONLY IN ROAD CUT IN IMMEDIATE AREA	4 FT		Kootenai	Sunburst	-		40/60	fail	0.644	0.592	20.3	25.4				Yes	No
GFS-10-SV-13	47.46126	-111.21637	NAV-	NAD83	3384	20N	04E	27	BB	CASCADE	Kks	AT LG BOULDER FROM OC ABOVE, ALONG FENCE LINE GIBSON FLATS RD; QUARTZOSE, ROCK COLOR CHART; WHITE (N9), VERY LIGHT GREEN (N8) & VERY PALE ORANGE (10 YR 8/2); POROUS; FINE GRAINED; NO REACTION TO ACID, EXTENT: OVER 1 MILE AROUND HILL	40-60		Kootenai	Sunburst	-		70/140	pass	0.640	0.548		8.8	11.9			Yes	No
GFS-11-SV-13	47.37977	-111.43902	NAV-	WGS84	3530	19N	02E	23	DC	CASCADE	Kblf	WILSON BUTTE RD N OF LORD COULEE ALONG SWITCHBACK; ROADCUT; MOSTLY PINK AND WHITE QUARTZ, LIMONITE, WT CLAY, BL GRAINS, EXTENT REGIONALLY EXTENSIVE CAPROCK	~150		Blackleaf	Flood	760.3	439	16/30	fail						No	No
GFS-12-SV-13	47.29385	-111.42662	NAV-	WGS84	3420	18N	02E	24	CC	CASCADE	Kks	MILLEGAN RD S OF W EDEN RD ALONG SMITH R; ROADCUT; TYPICAL SUNBURST, MOSTLY QUARTZ GRAINS WITH LIMONITE SPECKS, SOME CLAY, BL CHERT, EXTENDS FOR MILES ABOVE SMITH RIVER	~30		Kootenai	Sunburst	-	-	70/140	pass	0.659	0.675	6.3	11.3				Yes	No
GFS-13-SV-13	47.24529	-111.35992	NAV-	WGS84	3773	17N	03E	9	BA	CASCADE	Kks	BOSTON COULEE RD N OF MURPHY COULEE; ROADCUT; RIPPLEMARKS; MOSTLY QUARTZ GRAINS; SOME LIMONITE, PINK AND BL GRAINS, WT CLAY	~25		Kootenai	Sunburst	-	-	40/70	fail				32.2				Yes	No
GFS-14-SV-13	47.23266	-111.28306	NAV-	WGS84	4181	17N	03E	12	DD	CASCADE	Kks	EDEN RD S OF EDEN; SLABS OF ROCK ON SURFACE; MOSTLY QUARTZ GRAINS; V SM AMOUNT BL CHERT; EXPOSED OR NEAR SURFACE FOR MILES	~20		Kootenai	Sunburst	-	-	70/140	pass	0.652	0.683		7.5	10.3	11.8		Yes	No
GFS-15-SV-13	47.28449	-111.10326	NAV-	WGS84	4320	18N	05E	28	AC	CASCADE	Kks	MUNDT RD W OF "THREE FORKS"; SLABS OF ROCK ON SURFACE; NEARLY PURE QUARTZ SAND WITH LIMONITE SPECKS; EXPOSED OR NEAR SURFACE FOR MILES	~30		Kootenai	Sunburst	-	-	70/140	fail	0.673	0.693	10.5	12.5				Yes	No
GFS-16-SV-13	47.31526	-111.13943	NAV-	WGS84	4624	18N	05E	18	AA	CASCADE	Kks	COTTONWOOD COULEE RD; ROADCUT; MOSTLY QUARTZ GRAINS, LIMONITE SPECKS, A LITTLE BL CHERT; ~5 FT EXPOSED, EXPOSED OR NEAR SURFACE FOR MILES	~20		Kootenai	Sunburst	-	-	70/140	pass	0.655	0.681		7.6	9.9	12.9		Yes	No

Sample Name	Latitude	Longitude	Geomethod	Datum	Elev	TWN	RNG	Sec	Qse	County	Geo Symbol	Sampler Notes	Thick (ft)	Extent (ft)	Form'n Name	Member	Pre Wash	Post Wash	Tested Mesh Size	P/F	Spher	Roundness	Percent Fines 5K psi	6K psi	7K psi	8K psi	9K psi	>90% Silica	Clusters
GFS-18-SV-13	47.16651	-111.41218	NAV-	WGS84	4050	16N	02E	1	AD	CASCADE	Kks	UPPER MILLEGAN RD, S OF STREETER HILL; SLABS OF ROCK ON SURFACE; QUAD; MOSTLY QUARTZ GRAINS, V SMALL AMT BL CHERT GRAINS, EXPOSED SQUARE MILES, BUT PROBABLY AS LENSES	~5		Kootenai	Sunburst	-	-	40/60	fail	0.650	0.638	18.0	25.0				Yes	No
GFS-19-SV-13	47.14088	-111.41181	NAV-	WGS84	4194	16N	02E	13	AD	CASCADE	Kks	UPPER MILLEGAN RD, S OF STREETER HILL; SLABS OF ROCK ON SURFACE; ALMOST NOTHING BUT QUARTZ GRAINS; EXPOSED SQUARE MILES, BUT PROBABLY AS LENSES	<5		Kootenai	Sunburst	-	-	70/140	pass	0.667	0.674		5.0	10.3	16.7		Yes	No
GFS-20-SV-13	47.03229	-111.55112	NAV-	WGS84	4564	15N	01E	24	DA	CASCADE	Kks	ADEL RD ALONG ALLEN CREEK, N OF ENTRIES TO SIEBEN AND BK RANCHES; TYPICAL SUNBURST-MOSTLY QUARTZ GRAINSWITH LIMONITE SPECKS; 5 FT EXPOSED; NOT VERY EXTENSIVELY EXPOSED HERE BUT PROBABLY CLOSE TO SURFACE MAPPED AS NEAR SURFACE ON NEARLY DIP SLOPE. EXPOSED OR NEAR SURFACE SEV SQ MILES	5		Kootenai	Sunburst	-	-	70/140	pass	0.662	0.651		5.8	10.8			Yes	No
GFS-21-SV-14	47.44009	-111.484217	NAV-	NAD83	3506	20N	2E	33	CA	CASCADE	Kblf	Along N Ulm Frontage rd east of Ulm, n. of I-15; sampled lower of two ss beds in Kblf			Blackleaf	Flood	683.7	426.2	40/70	fail								No	No
GFS-22-SV-14	47.3994	-111.530143	NAV-	NAD83	3344	19N	2E	18	BD	CASCADE	Qe	Dunes fishing access area off of frontage rd between Missouri River and I-15			Eolian		112	105.3	40/70	fail								No	No
GFS-24-SV-14	47.457636	-111.506614	NAV-	NAD83	3446	20N	2E	29	DB	CASCADE	Kblf	Along Ulm-Vaughn Rd; upper ss			Blackleaf	Flood	851.3	265.1	70/140	fail	0.636	0.397						Yes	No
GFS-25-SV-14	47.39356	-111.03321	NAV-	NAD83	5326	19N	5E	13	DD	CASCADE	Kks	Along Spring Creek Rd, e of Spring Creek			Kootenai	Sunburst	1065.4	445.2	40/70	fail	0.653	0.588	15.9	21.9				Yes	No
HL-01-SV-14	44.979545	-111.861537	NAV-	WGS84	9358	10S	02W	9	BC	MADISON	Psh	GRAVELLY RANGE: ALONG GRAVELLY RANGE RD PART OF RD290, TALUS-COVERED HILL	~200		Shedhorn		527	416.5	16/30	fail								Yes	Yes
HL-02-SV-14	44.911729	-111.813007	NAV-	WGS84	8798	11S	02W	2	BA	MADISON	*q	GRAVELLY RANGE: ALONG RD 237 EAST OF BIG HORN MTN, LOOSE BLOCKS FROM OC ABOVE	~250		Quadrant		295.1		70/140	pass	0.641	0.613	7.9	10.2				Yes	No
HL-03-SV-14	44.850346	-111.869837	NAV-	WGS84	9296	11S	02W	29	AB	MADISON	Kt	ALONG GRAVELLY RANGE RD, THICKNESS ~30 FT; OC ON HILL CREST, LOOSE SS BLOCKS ALONG RD, EXTENSIVE BAND; KOOTENAI GASTROPOD LS QUARRIED FOR RDS NEARBY; KT BASAL SS OVERLIES IT	~30		Thermopolis		1245.1	556.8	70/140	pass	0.655	0.655		4.5	10.6			Yes	No
HL-04-SV-14	44.826513	-111.870189	NAV-	WGS84	9310	11S	02W	30	DC	MADISON	Kt	ALONG GRAVELLY RANGE RD, EXTENSIVE BAND; KOOTENAI GASTROPOD LS QUARRIED FOR RDS NEARBY; KT BASAL SS OVERLIES IT	~30		Thermopolis		869.2	457.9	70/140	Fail	0.663	0.424						Yes	No
HL-05-SV-14	44.802567	-111.237545	NAV-	WGS84	6547	12S	04E	10	BA	GALLATIN	f	ALSON HWY 287 NEAR LAKEVIEW N OF HEBGEN LAKE, OC LIMITED TO N OF HWY	~100		Flathead		608.5		30/50	fail	0.621	0.559	23.7	25.2				Yes	No
LIMA-01-SV-14	44.658805	-112.771258	NAV-	WGS84	6317	13S	10W	36	CB	BEAVERH	*q	TENDOY RANGE: ALONG BIG SHEEP CREEK RD, BEAVERHEAD NATIONAL FOREST, TENDOY MOUNTAINS, SAMPLED LOWER PART JUST ABOVE SNOWCREST RANGE GP; EXTENSIVE	~500		Quadrant		592.6		70/140	fail	0.650	0.483						Yes	No
LIMA-02-SV-14	44.657719	-112.774422	NAV-	WGS84	6381	13S	10W	36	CB	BEAVERH	*q	TENDOY RANGE: ALONG BIG SHEEP CREEK RD, BEAVERHEAD NATIONAL FOREST, TENDOY MOUNTAINS, SAMPLED LOWER MIDDLE PART OF FM; EXTENSIVE OC AND LOOSE BLOCKS	~500		Quadrant		-	249.6	40/70	fail	0.653	0.588	26.7	32.7				Yes	No
LIMA-03-SV-14	44.653248	-112.779823	NAV-	WGS84	6449	13S	10W	35	DD	BEAVERH	*q	TENDOY RANGE: ALONG BIG SHEEP CREEK RD, BEAVERHEAD NATIONAL FOREST, TENDOY MOUNTAINS, SAMPLED UPPER MIDDLE PART OF FM; EXTENSIVE SS RUBBLE	~500		Quadrant		878.6	767	70/140	pass	0.656	0.614	8.3	11.9				Yes	No
LIMA-04-SV-14	44.645591	-112.782381	NAV-	WGS84	6390	14S	10W	2	AC	BEAVERH	*q	TENDOY RANGE: ALONG BIG SHEEP CREEK RD, BEAVERHEAD NATIONAL FOREST, TENDOY MOUNTAINS, SAMPLED FARTHER UP ROAD THAN LIMA-3, EXTENSIVE TALUS	~500		Quadrant		827	457.9	70/140	pass	0.657	0.655		7.9	8.8	12.5		Yes	No
LIMA-05-SV-14	44.637965	-112.791862	NAV-	WGS84	6446	14S	10W	11	CC	BEAVERH	*q	TENDOY RANGE: ALONG BIG SHEEP CREEK RD, BEAVERHEAD NATIONAL FOREST, TENDOY MOUNTAINS, SAMPLED UPPER PART OF FM, JUST BELOW PP; EXTENSIVE OC AND TALUS	~500		Quadrant		609.1	509.8	70/140	pass	0.649	0.622		8.6	11.2			Yes	No
LIMA-06-SV-14	44.531993	-112.703073	NAV-	WGS84	7111	15S	09W	16	AC	BEAVERH	*q	TENDOY RANGE: ALONG MIDDLE FORK LITTLE SHEEP CREEK TRAIL OFF WHERE ROAD 3929 ENDS, BUT USED TO CONTINUE; JUST PAST TRAILHEAD WHERE TRAIL CROSSES STREAM, LIMITED EXPOSURE, BUT EXTENSIVE IN OTHER AREAS.	~30		Quadrant		732.5	531.9	40/70	fail	0.663	0.594	19.3	23.8				Yes	No
LIMA-07-SV-14	44.575974	-112.680253	NAV-	WGS84	6728	14S	09W	34	AB	BEAVERH	*q	TENDOY RANGE: ALONG ROAD 3929 ALONG MIDDLE FORK LITTLE SHEEP CREEK, SS BLOCKS ON HILLSIDE FROM OC ABOVE	~500		Quadrant		939.8	383.4	70/140	fail	0.672	0.661	13.4	18.0				Yes	No
LIMA-08-SV-14	44.579585	-112.692466	NAV-	WGS84	6753	14S	09W	34	BB	BEAVERH	*q	TENDOY RANGE: ALONG WEST FORK LITTLE SHEEP CREEK ROAD, SS BLOCKS ON HILLSIDE FROM OC ABOVE	~500		Quadrant		1339.7	907.2	70/140	pass	0.655	0.658	8.9	11.7				Yes	No
LIMA-09-SV-14	44.574922	-112.678518	NAV-	WGS84	6738	14S	09W	34	AB	BEAVERH	*q	TENDOY RANGE: ALONG EAST CREEK CAMPGROUND ROAD OFF OF EAST FORK LITTLE SHEEP CREEK, SAMPLED ALONG RD (PHOTO A), BUT BETTER EXPOSURES ACROSS CREEK ON OTHER SIDE (PHOTO B)	~50		Quadrant		868.1	435.6	70/140	fail	0.671	0.486						Yes	No
LIMA-10-SV-14	44.744369	-112.286115	NAV-	WGS84	7245	12S	06W	36	CA	BEAVERH	Kblf	SNOWCREST RANGE FLANK: JUST N OF WHERE RD 202 CROSSES SOUTH FORK ROUGH CREEK N OF LIMA RESERVOIR, INDETERMINATE THICKNESS, LOOSE BLOCKS ALONG RD, MAPPED AS LOCAL LANDSLIDE IN KOOTENAI AND ELLIS	IND		Blackleaf	Flood	1175.3	1008.2	70/140	fail	0.685	0.643	12.1	17.4				Yes	No

Sample Name	Latitude	Longitude	Geomethod	Datum	Elev	TWN	RNG	Sec	Qsec	County	Geo Symbol	Sampler Notes	Thick (ft)	Extent (ft)	Form'n Name	Member	Pre Wash	Post Wash	Tested Mesh Size	P/F	Spher	Roundness	Percent Fines 5K psi	6K psi	7K psi	8K psi	9K psi	>90% Silica	Clusters
LIMA-11-SV-14	44.756506	-112.30003	NAV-	WGS84	7124	12S	06W	25	CA	BEAVERH	*q	SNOWCREST RANGE: ALONG RD 202 NORTH OF LIMA RESERVOIR, LOOSE BLOCKS ON HILLSIDE + OC ON BOTH SIDES OF RD	~500		Quadrant		1122	729	70/140	pass	0.657	0.665	6.5	12.0				Yes	No
ME-01-SV-14	46.733422	-113.585227	NAV-	NAD83	3720	11N	16W	2	CB	MISSOUL	_f	N at Beavertail (Bonita) exit off I-90, left at T, right onto road along Cramer Creek			Flathead		650	572.2	30/50	fail								Yes	yes
MED_LAKE	48.40374	-104.3552	NAV-	NAD83	2055	31N	57E	31	AB	Sheridan	Qe	Fine-Medium greenish-grey unconsol. Sand; lots of miscellaneous material, Subangular, Mod Sorted			Eolian		380.4	358.7	40/70	fail	0.620	0.650	13.0					yes	No
ML-01	48.445	-104.3208	UNKN	NAD83	2045	31N	57E	16		SHERIDA	Qe	-			EOLIAN		-	-	40/70	fail								No	No
ML-02	48.4443	-104.308	UNKN	NAD83	2065	31N	57E	16		SHERIDA	Qe	-			EOLIAN		-	-	20/40	fail								No	No
ML-03	48.4429	-104.3093	UNKN	NAD83	2015	31N	57E	16		SHERIDA	Qe	-			EOLIAN		-	-	70/140	fail								No	No
RING-01-SV-14	46.209226	-110.865616	NAV-	WGS84	5641	05N	07E	9	BC	MEAGHE	Kt	SIXTEEN MILE CR RD OFF OF MEADOW CR RD S OF RINGLING, BASAL KT SS; THICKNESS INDETERMINATE, LOOSE SS BLOCKS	IND		Thermopolis		610.2	471.1	70/140	pass	0.651	0.620		7.4	10.7			Yes	No
SGVIR_01	48.99359	-111.95258	NAV-	NAD83	3502	37N	03W	2		TOOLE	Kvi	VERY FINE GAINED, GRADATION AND MORE FRIABLE TOWARD BOTTOM, GRAY, DARK GRAY/BORWN WEATHERING. SOFT AND FRIABLE AFTER FIRST 1.5 FT., 50M PERIMETER	1.5M		Virgelle		1383	715.9	70/140	fail	0.614	0.523						Yes	No
SGVIR_02	48.99359	-111.95258	NAV-	NAD84	3504	37N	03W	2		TOOLE	Kvi	WHITE, WEATHERS BROWN, SOMEWHAT FRIABLE	'5	5	Virgelle		1401.4	938.5	70/140	fail	0.613	0.39						Yes	No
SGVIR_03	48.96828	-111.9651	NAV-	NAD85	3616	37N	03W	14		TOOLE	Kvi	YELLOW,FINE GRAINED,FRIABLE, PURE, CLEAN	20	20	Virgelle		-	-	70/140	fail	0.594	0.515						Yes	No
SGVIR_04	48.9683	-111.96506	NAV-	NAD86	3620	37N	03W	14		TOOLE	Kvi	20FT EXPOSED, MEDIUM BROWN, LAYERING BEDDING DECREASES IN SIZE FROM TOP TO BOTTOM,NOT FRIABLE, LOOKS MOSTLY WEATHERED, SEVERAL 100 FT			Virgelle		1421.5	1077.9	70/140	fail	0.617	0.527						Yes	No
SGVIR_05	48.96786	-111.96738	NAV-	NAD87	3616	37N	03W	14		TOOLE	Kvi	SPECKLED GRAY AND BORWN, HEAVILY BEDDED 1-2CM THICKNESS, VERY FRIABLE	`20	100'S	Virgelle		-	924.3	70/140	fail	0.599	0.450						Yes	No
SGVIR_06	48.96752	-111.96842	NAV-	NAD88	3622	37N	03W	17		TOOLE	Kvi	YELLOW, HIGHLY FRIABLE, BEDDING ABOUT 1-2 IN THICK, PURE, FINE GRAINED			Virgelle		-	840.2	70/140	fail	0.591	0.441						Yes	No
TOWN-01-SV-14	46.12114	-111.408028	NAV-	WGS84	3977	04N	03E	7	BB	GALLATI	*q	TOSTON DAM RD AT TOSTON DAM, OC EXTENDS ACROSS MEANDER LOOP	~200		Quadrant		656.2	522.8	40/70	fail								YES	yes
VAL-01-SV-14	48.257414	-112.208081	NAV-	NAD83	3842	29N	05W	23	AD	PONDER	Kvi	Along Division South Rd, micaceous, doesn't appear to be a good candidate			Virgelle		340.4	273.7	70/140	fail	0.630	0.558	17.7	30.9				Yes	No
VAL-02-SV-14	48.233431	-112.234572	NAV-	NAD83	3822	29N	05W	34	DA	PONDER	Kvi	Along Division South Rd			Virgelle		580.5	466.1	40/70	fail	0.624	0.497						Yes	No
WSS-01-SV-14	46.566077	-110.809669	NAV-	NAD83	5434	09N	07E	2	DC	MEAGHE	Kk	Rd cut along hwy 12 ne of White Sulphbur Springs, 2 1/2 mi e of junction w hwy 89; sampled ss in strat position of Kks			Kootenai		714.6	523.1	40/70	fail	0.662	0.500	11.1	15.0				Yes	No
WSS-02-SV-14	46.767276	-110.804047	NAV-	WGS84	5843	12N	02E	26	DD	MEAGHE	_f	ALONG HWY 89 WEST OF FOREST GREEN, THICKNESS ~50 FT; SAMPLED LOOSE BLOCK, OC AND LOOSE SS BLOCKS CONTINUOUS ALONG HWY FOR ~ 1/8 MI	~50		Flathead		789.2	754.2	30/50	pass	0.633	0.604	8.9	14.0	20.2			Yes	No
WSS-03-SV-14	46.859763	-110.666615	NAV-	WGS84	6913	13N	08E	26	AC	CASCADE	_f	ALONG RD 3228 NEAR HWY 89, EXTENSIVE, BUT A LOT IS IN TREES, THICKNESS INDETERMINATE; SAMPLED LOOSE BLOCK, OC AND LOOSE SS BLOCKS HERE AND ALONG HWY 89 TO SW, SOME FRIABLE, SOME NOT	IND		Flathead		942.2	859.2	30/50	fail	0.621	0.575	29.0	29.3				Yes	No
WSS-04-SV-14	46.858729	-110.668115	NAV-	WGS84	6878	13N	08E	26	AC	CASCADE	_f	ALONG HWY 89 SW PF RD 3228, THICKNESS INDETERMINATE; SAMPLED LOOSE BLOCK, LOOSE SS BLOCKS, EXTENSIVE, BUT MOSTLY IN WOODS			Flathead		993.7	812.7	30/50	fail	0.640	0.585	24.3	32.8				Yes	No
WSS-05-SV-14	46.858737	-110.676431	NAV-	WGS84	7055	13N	08E	26	CB	CASCADE	_f	PILE OF BLOCKS ON N SIDE OF KINGS HILL WINTER REC PARKING LOT BEHIND OUTHOUSE, THICKNESS INDETERMINATE; SAMPLED LOOSE BLOCKS PILED BY EXCAV, REPRESENTATIVE OF EXTENSIVE _F IN AREA	IND		Flathead		919.6	847.7	30/50	fail	0.636	0.585	13.3	29.3				Yes	No
WSS-06-SV-14	46.992898	-110.813873	NAV-	WGS84	6192	14N	07E	10	AA	CASCADE	_f	ALONG BELT PARK RD, NEAR RAFFERTY CR, THICKNESS INDETERMINATE; SS BLOCKS; COARSER GRAINED, SOME GR, EXTENSIVE IN BELT PARK, BUT MUCH SOIL ON BENCH TOPS	IND		Flathead		664.2	571.9	20/40	fail								Yes	yes
WSS-07-SV-14	46.976902	-110.81373	NAV-	WGS84	6568	14N	07E	15	AD	CASCADE	_f	ALONG BELT PARK RD E OF BELT PARK BUTTE, THICKNESS INDETERMINATE; OC AND SS BLOCKS; MORE FRIABLE HERE, EXTENSIVE IN BELT PARK, BUT MUCH SOIL ON BENCH TOPS	IND		Flathead		1094.4	828.6	40/60	fail	0.646	0.655	17.0	20.7				Yes	No

TOTAL SAMPLES: 317

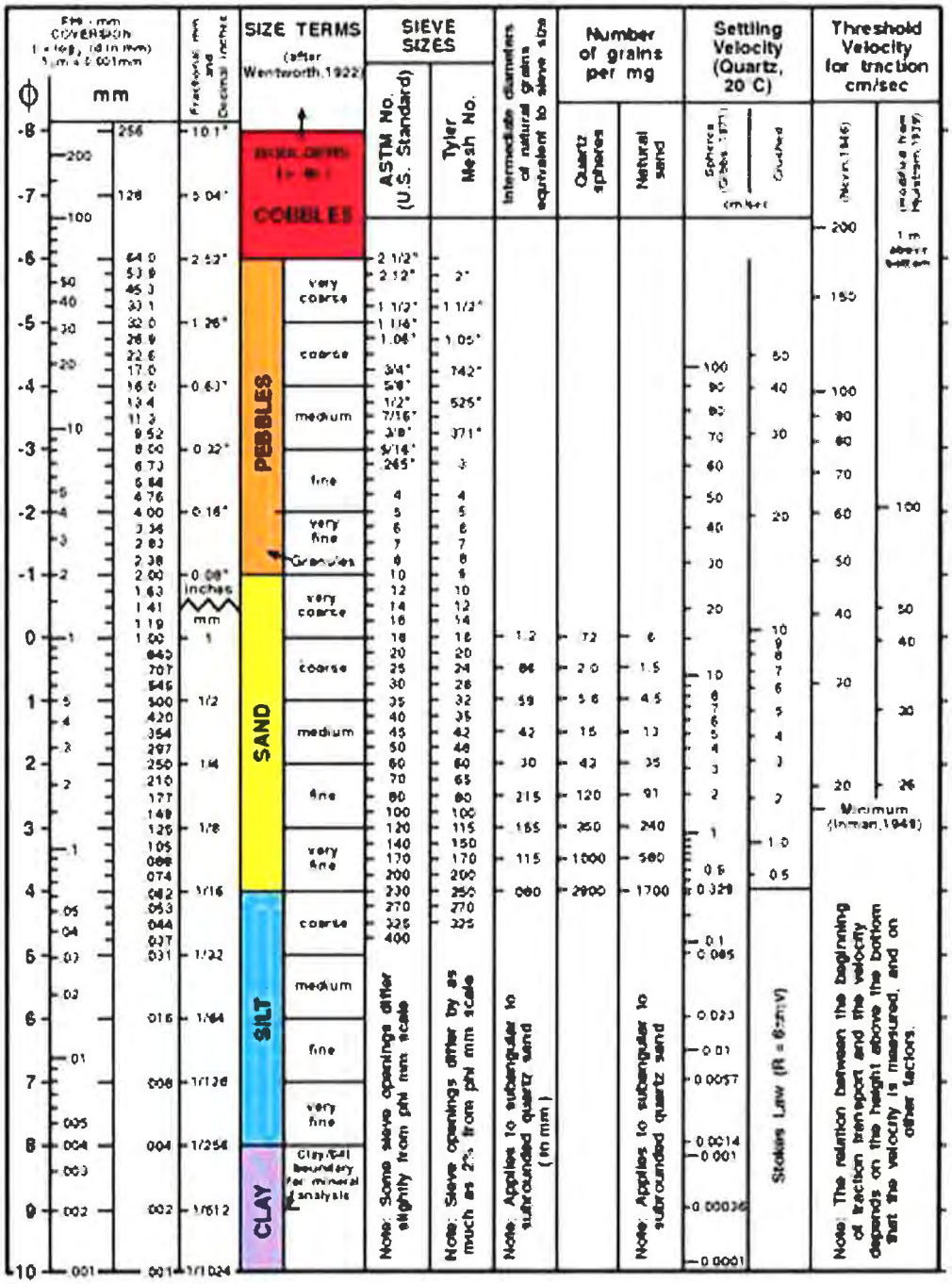
NOT INCLUDED INTO DATABASE: 31 SAMPLES

B48-1																													
A40-5	48.45005	-105.68529	NAV-	NAD83		31N	46E	13	AB	ROOSEVE	Qg	14.5 MI E OF FRAZ-RICH RD ON WALL ST. (17-2038), INTERSECT W/ 17-1076 | GLACIAL TILL, SANDY W/ ABUNDANT GRAVEL (FLAXVILLE) - POOR SAMPLE			Glacial														
B35-1	48.03049	-106.31563	NAV-	NAD83		26N	42E	4	DD	MCCONE	Kfh	RADIO TOWER HILL 2 MI EAST OF FT PECK SPILLWAY | WHITE/GRAY UNCONSOLIDATED SS, CAPPED BY THIN XBEDDED UNIT	50	1000	Fox Hills														
C86-1	47.1259	-104.19888	NAV-	NAD83	2580	16N	59E	24	CB	Wibaux	Tftr	vf-f grnd clayey qtz+black lithics/chert ss, well sorted, Rounded, Very Friable			Fort Union	Tongue River													
C87-1	47.58915	-105.0844	NAV-	NAD83	2485	21N	52E	8	CC	Dawson	Tftr	vf-f grnd, clayey qtz + black lithics/chert ss, Well Sorted, Rounded, Very Friable			Fort Union	Tongue River													

Sample Name	Latitude	Longitude	Geomethod	Datum	Elev	TWN	RNG	Sec	Qsec	County	Geo Symbol	Sampler Notes	Thick (ft)	Extent (ft)	Form'n Name	Member	Pre Wash	Post Wash	Tested Mesh Size	P/F	Spher	Roundness	Percent Fines 5K psi	6K psi	7K psi	8K psi	9K psi	>90 % Silica	Clusters
C88-1	47.70344	-104.91209	NAV-	NAD83	2530	23N	53E	34	CC	Richland	Tftr	white/ tan f-med grnd qrtz ss + lithics, subrounded, calcareous, moderately sorted, Very friable			Fort Union	Tongue River													
C89-1	48.01085	-104.95366	NAV-	NAD83	2345	26N	52E	13	BB	Richland	Tftr	White/Tan vf-f grnd clayey quartz-rich SS, Subangular, mod Sorted, Friable			Fort Union	Tongue River													
C90-1	47.26955	-106.3374	NAV-	NAD83	2552	18N	42E	35	CC	Garfield	Tftr	White/Tan vf-f grnd clayey quartz-rich ss, Sub-ang, Mod Sorted, calcareous cmt, friable			Fort Union	Tongue River													
SAND 1 SOUTH OF RICHEY																													
SAND 2 NE OF RICHEY																													
SAND 3 POPULAR																	574	394.5											
SAND 4 COHAGEN																													
SAND 5 WIBAUX																													
FAIRY LAKE (33 FL)																													
FAIRY LAKE 34FL																													
GFS-17-SV-13	47.20575	-111.42204	NAV-	WGS84	3698	17N	02E	24	CD	CASCADE	Kks	MILLEGAN RD NEAR HOUND CREEK; ROADCUT WHERE SUNBURST SHOULD BE; NOT SAMPLED, TOO THIN OR ABSENT, VERY FINE GRAINED; VERY SPOTTY EXPOSURE, ROADCUT IS BETWEEN LENSES OF SS, SPOTTY	0-5		Kootenai	Sunburst													
RIM-01	45.900728	-108.481313	NAV-	NAD83	3201	02N	26E	22		YELLOWS	Ke	SWORDS PARK; MASSIVE XBEDDED SS (IMMATURE ARENITE); TRIMBLE PRACTICE	40	9999	Eagle														
GFS-23-SV-14	47.380979	-111.438646	NAV-	WGS84	3590	19N	02E	23	DB	CASCADE	Kblf	WILSON RD DID NOT SAMPLE: TOO FINE-GRAINED, TOO MANY LITHIC GRAINS			Blackleaf	Flood													
ELL-06-SV-14	46.60607	-112.780441	MAP	WGS84	5467	10N	09W	19	CA	POWELL	*q	NORTH ON WARM SPRINGS RD BETWEEN I-90 PHOSPHATE AND GARRISON EXITS, ACCESS FROM FRONTAGE ROAD,DID NOT SAMPLE, FROM DISTURBED AREA; TOO TIGHTLY CEMENTED, QUARTZITE			Quadrant														
B55-1	45.10865	-108.6174	NAV-	NAD83	4961	08S	25E	26	DA	CARBON	IPt	QUARRY RD NE OF WARREN; N. SIDE AS QUARRY ROAD TURNS EAST; LAMINATED, YELLOW-WHITE VF GRND FRIABLE QTZ SAND	20	9999	Tensleep														
B55-2	45.10937	-108.6175	NAV-	NAD83	5006	08S	25E	26	DA	CARBON	IPt	QUARRY RD NE OF WARREN; N. SIDE AS QUARRY ROAD TURNS EAST; VF GRND QTZ SAND; MASSIVE BEDDING WITH SOME MED-SCALE XBEDS; DUNES ; UP SECTION FROM B55-1 TO NEXT MAJOR DUNE PACKAGE	15	9999	Tensleep														
FS1																	-	-	70/140	fail								Yes	yes
FS2																	-	-	70/140	fail								Yes	yes
C91-1	46.72357	-109.1759	NAV-	NAD83	5732	11N	20E	11	CC	Golden V	Mk	yellow/White calcareous Fine grained qtz ss, Rounded, Mod Sorted, bimodal grain size dist?	3	200	Kibbey														
C93-1	46.308154	-107.1371	NAV-	NAD83	3415	06N	32E	3	BB	Yellowsto	Tftr	dirty, subangular, VF-F grnd SS, Friable	15	100	Fort Union	Tongue F	137.1	139.9											
C70-1	46.71237	-109.34825	NAV-	NAD83	5800	11N	19E	17	DD	Golden V	Ipma	outcrop of mixed lithology - LS, SH, SS of Amsden; sample is fine grnd (Lower 0.125-0.177mm), Subangular, Well Sorted	4	10	Amsden														
B61-3	46.95128	-109.53411	NAV-	NAD83	4355	14N	17E	26	BA	FERGUS	Kk	NE SIDE OF BEAVER CK RD; 150 YDS SOUTH OF INTERSECTION WITH FARREN HILL RD; THIN-BEDDED (1-2" BEDS), FINE GRND QTZ+LITHIC SAND	8	50	Kootenai														
B61-4	46.95128	-109.53411	NAV-	NAD83	4355	14N	17E	26	BA	FERGUS	Kk	NE SIDE OF BEAVER CK RD; 250 YDS SOUTH OF INTERSECTION WITH FARREN HILL RD; MASSIVE BEDDED, BROWNISH MED GRND QTZ ARENITE, MOD SORTING	8	50	Kootenai														
B54-1	47.76687	-109.29885	NAV-	NAD83	2400	23N	19E	16	BC	FERGUS	Kjr	NO MAN'S LAND; FINE-MED GRND JUDITH RIVER SAND; CLEAN QTZ SAND	20		Judith River		147.2	148											
B61-1	46.95128	-109.53411	NAV-	NAD83	4355	14N	17E	26	BA	FERGUS	Kk	NE SIDE OF BEAVER CK RD; 150 YDS SOUTH OF INTERSECTION WITH FARREN HILL RD; MED GRND, MOD SORTED, GRAY, CHERTY/LITHIC QTZ SS; XBEDDED, MOD SORTED	8	50	Kootenai														
DILL-09-SV-14	45.145942	-112.72222	NAV-	WGS84	6541	08S	09W	9	AC	MADISON	Tvs	NE OF BARRETT EXIT OFF I-15 AT FORD, NE OF RR TRACKS, THICKNESS VARIABLE; UNKNOWN; SED/ASH ASSOCIATED WITH VOLCANIC ROCK	IND		VOLCANIC SEDIMEN		320.1	115.2	70/140	fail	0.522	0.547						Yes	No
DILL-10-SV-14	45.116149	-112.751854	NAV-	WGS84	5303	08S	09W	19	AD	MADISON	Tvs	NE OF DALYS EXIT OFF I-15, RD CUT WEST OF BEAVERHEAD RIVER, THICKNESS VARIABLE, SED/ASH ASSOCIATED WITH VOLCANIC ROCK	VAR		VOLCANIC SEDIMEN		330.8	176.2	40/70	fail								No	YES

Intentionally blank

Appendix B: Wentworth Grain Size Table



Wentworth Grain size chart (USGS, 2003). Available at http://pubs.usgs.gov/of/2003/of03-001/htmldocs/images/chart.pdf.

Appendix C: SNaP Field Sampling Form

SNaP	Field Data Collection Form for Grab Samples	SID (MBMG Only)	
Sample # *		Name of Sampler *	
Date *		Email	
GPS		Formation Information	
LAT (decimal)		Formation Name	
LONG (decimal)		Thickness	
Elevation (ft)		Exposed	
		Unit	
Township		Extent	
Range		Pictures	
Section		How many *	
County		Picture Numbers *	
QuadrangleName			1:100,000
QuadrangleName			7.5'
Sample Characteristics			
Color			
Grain Shape			
Reaction to Acid			

Instructions

Complete as many fields as possible. Except for those cells marked with *, you may leave it blank
In order to process the samples, a data collection form should be submitted for each sample
Provide Lat and Long in decimal degrees, (eg 46.7890123), Date is when the sample was collected
Please email pictures of the sample location to proppantresearch@mtech.edu
If you want results on your sample, please include your email address
Data collected becomes the property of Montana Tech and will be made available to the general public

Appendix D: Measured Sections References and Notes

Reference	Notes
Gardner, L.S.,1959, Revision of the Big Snowy Group in Central Montana: American Association of Petroleum Geologists, v. 43, no. 2, p. 329-349	
Hanson, A.M.,1952, Cambrian Stratigraphy in southwestern Montana: Montana Bureau of Mines and Geology, Memoir no. 33, p. 25-41.	Typically, the lower part of the Flathead Formation has more potential than higher in the section where there is usually sandstone interbedded with shale and more clay present. Also farther north and west showed more promise than the south and eastern sections discussed in this paper.
Weed, W.H.,1900,Geology of the Little Belt Mountains, Montana: U.S. Geological Survey Annual Report no. 20, 1899-99, pt. 3, p. 284-318	
Deiss, C., 1936, Revision of type Cambrian Formations and sections of Montana and Yellowstone National Park: Geological Society of America Bulletin v. 47, p. 1257-1342.	
Deiss, C.F., 1939, Cambrian stratigraphy and trilobites of northwestern Montana: Geological Society of America Special Paper no. 18, 135 p.	
Dutro, T.J., 1979, Carboniferous of the northern Rocky Mountains, Big Snowy Mountains Region, Montana: AGI Selected Guidebook Series no. 3, p. 28.	
Harris, W.L.,1972, Upper Mississippian and Pennsylvanian sediments of Central Montana: University of Montana, Ph.D. dissertation, p. 1-58, 75-92,110-112,173-191,241-248.	Sandstones of the upper Kibbey are fine to very fine grained (0.2- 0.05 mm). Coarse grained sandstones are present on the northern side of the Little Belt Mountains and to the east. Larger grains are typically rounded to well rounded and smaller grains are angular. Mostly moderately to well sorted. Friable because of incomplete calcareous cementation. The uppermost unit of the Quadrant is well indurated because of almost complete siliceous cementation.
Gill, J.R., and Burkholder, R.E., 1979, Measured sections of the Montana Group and equivalent rocks from Montana and Wyoming: U.S. Geological Survey Open File Report 79-1143, 203 p.	

Reference	Notes
Lopez, D.A., and VanDelinder, S.W. 2007, Measured sections of the Pennsylvanian Tensleep Sandstone, Pryor and Bighorn Mountains, Montana: Montana Bureau of Mines and Geology, Open File Report 553, 55 p.	The lower 29 ft of the formation not included in the database has many thin layers, all composed of limy sandstone with calcareous matrix, They all have fine to very fine grain size and much cross bedding with parallel laminated section typical towards the bottom of this section. There is also a 1 ft section of siliceous sandstone followed by siltstone at the base of the "top lower Tensleep". The Amsden Formation underlies all of the above Tensleep formations from this reference.
Robinson, G. D., 1963, Geology of the Three Forks Quadrangle Montana: Geological Survey Professional Paper 370, 143 p.	
Richards, P.W., 1957, Geology of the area east and southeast of Livingston, Park County, Montana: U.S. Geological Survey Bulletin 1021-L, p. 385-436.	There is information in this reference about the Virgelle Formation (p. 417-419) but it does not indicate any specific locations for sandstone, nor does it describe its characteristics in any detail other than color and weathering.
Vine, J.D., 1956, Geology of the Stanford-Hobson area, central Montana: U.S. Geological Survey Bulletin 1027-J, p. 405-467.	Page 416 contains well log information which describes the Kibbey Formation as sandstones that are typically very fine grained to silty but there is one 15 ft section containing white, fine to medium grained sandstone.
Richards, P.W, 1955, Geology of the Bighorn Canyon - Hardin area, Montana and Wyoming: U.S. Geological Survey Bulletin 1026, 93 p.	
Easton, W.H., 1962, Carboniferous formations and faunas of central Montana: U.S. Geological Survey Professional Paper 348, 126 p.	Reference has detailed descriptions at the beginning of each section on how to get to the specific sites.

Reference	Notes
Mertie, J.B., 1951, Geology of the Canyon Ferry quadrangle, Montana: U.S. Geological Survey Bulletin 972, 95 p.	Reference does not contain any measured sections but describes the Flathead and the Quadrant Formations. Flathead (p. 21): brittle unit displaced by numerous small cross faults producing step-like outcrops. NW of Hellgate Gulch the Flathead is tightly folded and bent with little evidence of rupturing. It contains mostly medium to coarse quartzite grains and mostly pale gray with occasional purple and red banding. Quadrant Formation (p.28): Exposed along the front of the Big Belt Mountains in the vicinity of White Gulch and at places in the southeastern part of Spokane Hills. This formation consists of quartzite interbedded with limestone, sandstone, and shale. The quartzite is hard, tough, brittle and vitreous.The sandstone is thin-bedded and brown, red, or gray; most is soft and shaly, but some is quartzitic and other is calcareous.
Maughan, E.K., Roberts, A.E., 1967, Big Snowy and Amsden Groups and the Mississippian-Pennsylvanian boundary in Montana: U.S. Geological Survey Professional Paper 554-B, 27 p.	Reference describes the increasingly sandy trend towards the west for the Devil's Pocket Formation (p. B16). Also many of the sections have specific direction to outcrop sites and also span across more than one location. The first, or most specific, of the locations provided for each measured section is provided.
McKelvey, V.E., 1959, The Phosphoria, Park City, and Shedhorn Formations in the Western Phosphate field: U.S. Geological Survey Professional Paper 313-A, 45 p.	
Tysdal, R.G., 1970, Geology of the north end of the Ruby Range, southwestern Montana: University of Montana, Ph.D. dissertation, p. 133-180.	
Mann, J.A., 1954, Geology of part of the Gravelly Range, Montana: Yellowstone-Bighorn Research Project Contribution no. 190, p. 75-92.	

Reference	Notes
Knappen, R.S., and Moulton, G.F., 1930, Geology and mineral resources of parts of Carbon, Big Horn, Yellowstone, and Stillwater Counties, Montana: U.S. Geological Survey Bulletin 822-A, 70 p.	On page 37 there is information about the Eagle Sandstone, however it is not very descriptive. Much of the sandstone is interbedded with shale, clay, or coal. The Greybull Member is mentioned on page 26 but has no sandstone in its measured section. The Greybull is defined as a resistant sandstone with limonite cement with grain size less than 0.4mm. It has a high clay content.
Glasheen, R.M., 1969, Geology of the Whetstone Ridge area, Meagher County, Montana: Oregon State University, M.S. thesis, 137 p.	Reference has information on the Judith River and Lennep formations. None of the sandstone units appear promising because of either high lithic or feldspar content.
Witkind, I.J., 1969, Geology of the Tepee Creek quadrangle Montana-Wyoming: U.S. Geological Survey Professional Paper 609, 101 p.	
Mudge, M.R., 1972, Pre-Quaternary rocks in the Run River Canyon area, northwestern Montana: U.S. Geological Survey Professional Paper 663-A, 142 p.	Measured sections of the Blackleaf Formation, Flood Member are on p. 26. The Flood contains many layers of sandstone and it is all noncalcareous, mostly composed of quartz, feldspar, and chert. Each section is very fine grained. Also most of it is interbedded with shale and contains granules of claystone.
Klepper, M.R., Ruppel, E.T., Freeman, V.L., Weeks, R.A., 1971, Geology and mineral deposits, east flank of the Elkhorn Mountains, Broadwater County, Montana: U.S. Geological Survey Professional Paper 665, 66 p.	
Cobban, W.E., Erdmann, C.E., Lemke, R.W., Maughan, E.K., 1976, Type sections and stratigraphy of the members of the Blackleaf and Marias River Formations (Cretaceous) of the Sweetgrass Arch, Montana: U.S. Geological Survey Professional Paper 974, 66 p.	
McLane, M.J., 1971, Phanerozoic detrital rocks at the north end of the Tobacco Root Mountains, southwestern Montana: a vertical profile: Indiana University, Ph.D. dissertation, 253 p.	Reference includes detailed information about each unit except for thickness which was estimated for each unit from drawn stratigraphic sections.
Alexander, R.G., Jr.,1955, Geology of the Whitehall area, Montana: Yellowstone-Bighorn Research Project Contribution no. 95, 110 p.	

Reference	**Notes**
Mahorney, J.R., 1956, Geology of the Garrity Hill area, Deer Lodge County, Montana: Indiana University, M.A. thesis, 40 p.	The Quadrant section was not measured because of an excessive amount of Quadrant talus and cover.
Nave, F.R., 1952, Geology of a portion of the Bridger Range, Montana:State University of Iowa, M.S. thesis, 104 p.	
McMannis, W.J., 1952, Geology of the Bridger Range area, Montana: Princeton University, Ph.D. dissertation, 47 p.	
Wilson, M.D., 1970, Cretaceous stratigraphy of the southern Madison and Gallatin Ranges, southwestern Montana: University of Idaho, Ph.D. dissertation, 55 p.	
Childers, M.O., 1960, Structure and stratigraphy of the southwest Marias Pass area, Flathead County, Montana: Princeton University, Ph.D. dissertation, 181 p.	
Bierwagen, E.E., 1964, Geology of the Black Mountain area Lewis and Clark, and Powell Counties, Montana: Princeton University, Ph.D. dissertation, 46 p.	
Moberly, R.M., 1956, Mesozoic Morrison, Cloverly, and Crooked Creek Formations, Bighorn Basin, Wyoming and Montana: Princeton University, Ph.D. dissertation, 47 p.	There are some promising quartz arenites in the Cloverly Formation in Wyoming. The are medium- to fine-grained, friable, calcareous and sparkly. (Sec. 19, T. 57 N., R. 94 W.)
Loen, J.S., 1990, Lode and placer gold deposits in the Ophir district, Powell, and Lewis Clark Counties, Montana: Colorado State University, Ph.D. dissertation, 264 p.	
McGill, G.E., 1958, Geology of the northwest flank of the Flint Creek Range, western Montana: Princeton University, Ph.D. dissertation, 193 p.	The Flathead, Shedhorn, and Quadrant are described as relatively hard, pure quartzites. The Flathead is described as a first or second quality glass sand. It is not included in the database because tightly cemented, but is located in NE 1/4, SW1/4, Sec. 27, T. 09 N., R. 13 W. (p. 161).
Theodosis, S.D., 1956, The geology of the Melrose area, Beaverhead and Silver Bow Counties, Montana: Indiana University, Ph.D. dissertation, 118 p.	The uppermost Quadrant at one location is described as friable (p. 42). NW1/4, Sec. 30, T. 01 S., R. 09 W., and NW1/4 Sec. 13, T. 01 S., R. 09 W.,sec.13, NW. Elsewhere the Quadrant is tightly cemented in the Melrose area.

Reference	**Notes**
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Key, C.F., 1987, Stratigraphy and depositional history of the Amsden and Lower Quadrant Formations, Snowcrest Range, Beaverhead and Madison Counties, Montana: Oregon State University, M.S. thesis, 187 p.	
Christie, H.H., 1961, Geology of the southern part of the Gravelly Range, southwestern Montana: Oregon State College, M.S. thesis, 159 p.	
Rose, R.R., 1967, Stratigraphy and structure of part of the southern Madison Range, Madison and Gallatin Counties Montana: Oregon State University, M.S. thesis, 172 p.	
Austin, W.H., Jr., 1950, Reconnaissance geology of the south flank of Cinnamon Mountain, Gallatin County, Montana: University of Michigan, M.S. thesis, 102 p.	
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sectionId	Unit Symbol	Measured Section Name	TWP	Rng	Sec	Qsec	Loc Notes	Lat (Apprx)	Long (Apprx)	method	Hrzntl Datum	Page Num	Sub Unit Id	Description	Grain Size	Cementation	Roundness	Sorting	Thick Ft	Suit-ability?	Ref Id
1	Jsw	Stone House Ranch and State Road	11N	21E	31		section 31 & 32, T.11 N., R. 21 E.	46.67153	-109.127	TRS	NAD	338	141	Sandstone: impure, glauconitic		very resistant, not friable			5	no	1
2	IPdp	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	338	138	Quartzitic sandstone: friable, clean, cherty in places, white, gray, pink	medium	poorly bedded, nodular, friable, porous		well sorted	18	yes	1
3	IPdp	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	338	132	Sandstone: friable, massive, white to pink	fine	non-resistant, calcareous, friable			7	maybe	1
4	IPdp	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	338	131	Sandstone: quartzitic at top, gray purple	fine	calcareous			5	maybe	1
5	IPMt	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	339	97	Quartz sandstone: quartzitic at top, mud cracks and ripples, bedded with non-calcareous shale, gray - purplish brown	fine to medium	calcareous	subangular - subrounded		6	no	1
6	IPMt	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	339	95	Sandstone: porous, 'salt and pepper', massive and crossbedded, gray, white	medium	slightly calcareous, porous	angular quartz	well	4	no	1
7	Mk	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	341	29	Quartz sandstone: porous, massive, little bedding, gray/yellow	fine to medium	porous	clean subrounded		3	yes	1
8	Mk	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	341	27	Sandstone: interbedded with brown quartzitic sandstone, yellow	fine	non-resistant			7	yes	1
9	Mk	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	341	26	Quartz sandstone: friable, gray/yellow	fine to medium	calcareous, friable, porous	subangular	well	3	maybe	1
10	Mk	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	341	25	Sandstone: friable, cavities with calcite crystals, gray/yellow	fine	calcareous, friable	angular - rounded	poorly	6	maybe	1
11	Mk	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	341		Sandstone: friable, massive, vague bedding, gray	fine to medium to large	friable	subrounded - large rounded	poorly	2	maybe	1
12	Mk	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	341	21	Quartzitic sandstone: silty, bedded, yellow-gray with pink mottlings	fine to medium	calcareous	rounded to angular	poorly	16	no	1
13	Mk	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	341	19	Sandstone: porous, well bedded, mottled pink-yellow-gray	medium to coarse	calcareous, porous	larger rounded	poorly	28	maybe	1
14	Mk	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	342	15	Quartz sandstone: friable, bedded, pink, yellow-gray	medium	calcareous, non-resistant, friable, porous	rounded	well	3	yes	1
15	Mk	Stone House Ranch and State Road	11N	21E	31			46.67153	-109.127	TRS	NAD	342	14	Quartz sandstone: friable, poorly exposed, light yellow	fine	non-resistant, friable, porous		well	13	yes	1
16	Jsw	Stone House Ranch and State Road	11N	21E	32		section 31 & 32, T.11 N., R. 21 E.	46.67147	-109.106	TRS	NAD	338	141	Sandstone: impure, glauconitic		very resistant			5	no	1

Coordinates do not provide exact locations. They were derived from legal descriptions in the sources

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17	IPdp	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	338	138	Sandstone: clean, friable, quartzitic and cherty and nodular in places, poorly bedded, white, gray, pink	medium	poorly bedded, friable, porous		well	18	yes	1
18	IPdp	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	338	132	Sandstone: friable, massive, white to pink	fine	non-resistant, calcareous, friable			7	maybe	1
19	IPdp	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	338	131	Sandstone: quartzitic at top, gray purple	fine	calcareous			5	maybe	1
20	IPMt	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	339	97	Quartz sandstone: quartzitic at top, mud cracks and ripples, bedded with non-calcareous shale, gray to purplish brown	fine-medium	calcareous	subangular - subrounded		6	maybe	1
21	IPMt	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	339	95	Sandstone: porous, 'salt and pepper', massive, crossbedded; gray, white	medium	slightly calcareous, porous	angular quartz	well	4	no	1
22	Mk	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	341	29	Quartz sandstone: massive, little bedding, gray/yellow	fine to medium	porous	clean subrounded		3	yes	1
23	Mk	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	341	27	Quarzitic sandstone: yellow, interbedded with brown	fine	non-resistant			7	yes	1
24	Mk	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	341	26	Quartz sandstone: friable, bedded, gray/yellow	fine to medium	calcareous, friable, porous	subangular	well	3	maybe	1
25	Mk	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	341	25	Sandstsone: friable, cavities with calcite crystals, gray/yellow	fine	calcareous, friable	angular - rounded	poorly	6	maybe	1
26	Mk	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	341		Sandstone: friable, massive, vague bedding, gray	fine to medium to large	friable	subrounded - large rounded	poorly	2	maybe	1
27	Mk	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	341	21	Sandstone: quartzitic to silty, bedded, yellow-gray with pink mottlings	fine to medium	calcareous	rounded to angular	poorly	16	no	1
28	Mk	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	341	19	Sandstone: porous, well bedded, mottled pink - yellow - gray	medium -course	calcareous, porous	larger rounded	poorly	28	maybe	1
29	Mk	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	342	15	Quartz sandstone: friable, bedded, pink, yellow - gray	medium	calcareous, non-resistant, friable, porous	rounded	well	3	yes	1
30	Mk	Stone House Ranch and State Road	11N	21E	32			46.67147	-109.106	TRS	NAD	342	14	Quartz sandstone: friable, poorly exposed, light yellow	fine	non-resistant, friable, porous		well	13	yes	1
31	IPdp	Road Canyon section	11N	21E	31		section 31., T. 11 N , R. 21 E., Golden Valley County	46.67153	-109.127	TRS	NAD	343	30	Sandstone: clean, massive, white to pink	medium	slightly calcareous	subangular faceted quatrz sand	well	6	maybe	1
32	IPdp	Road Canyon section	11N	21E	31			46.67153	-109.127	TRS	NAD	343	23	Quartz sandstone: clean, white to pink	fine to medium	resistant	porous	well	9	yes	1

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33	Cf	Princeton	08N	13W	14	C	SW 1/4 sec. 14, SE 1/4 sec. 15, T. 8 N., R. 13 W.	46.44327	-113.1975	TRS	NAD	25		Quartzite sandstone: interbedded with shale (purple to green, fissile), tan to gray brown	thin to medium bedded				51	no	2
34	Cf	Princeton	08N	13W	14	C		46.44327	-113.1975	TRS	NAD	25		Sandstone and quartzite: thin to massive bedded, tan and brown weathering	medium to coarse			poorly	63	maybe	2
35	Cf	Princeton	08N	13W	15	D	SW 1/4 sec. 14, SE 1/4 sec. 15, T. 8 N., R. 13 W.	46.44306	-113.2078	TRS	NAD	25		Quartzite sandstone: interbedded with purple to green fissile shale, tan to gray brown	thin to medium bedded				51	no	2
36	Cf	Princeton	08N	13W	15	D		46.44306	-113.2078	TRS	NAD	25		Sandstone and quartzite: thin to massive bedded, tan and brown weathering	medium to coarse			poorly	63	maybe	2
37	Cf	Silver Hill	05N	13W	34		sec. 34, T. 5 N., R. 13 W.	46.14306	-113.2121	TRS	NAD	25		Quartzite: vitreous, medium to massive bedded, forms steep cliffs, brown - gray - purple	mostly medium, some coarse		subangular - angular	poorly	132	no	2
38	Cf	Silver Hill	05N	13W	34			46.14306	-113.2121	TRS	NAD	26		Quartzite: greenish purple to gray, cross bedded, thick bedded	medium		subangular - angular	poorly	22	no	2
39	Cf	Hecla	03S	11W	2		Hecla District sec. 2 T. 3 S., R.11 W., Beaverhead County	45.60413	-112.9277	TRS	NAD	26		Quartzite: greenish gray	fine				24	no	2
40	Cf	Hecla	03S	11W	2			45.60413	-112.9277	TRS	NAD	26		Quartzite: interbedded hornfels and litharenite, light to dark brownish gray	medium				7	no	2
41	Cf	Grasshopper Creek	09S	11W	11	D	Cambrian section NW of Armstead in SE 1/4 SE 11, T. 9 S., R. 11 W.	45.06281	-112.9108	TRS	NAD	27		Sandstone: many covered sections, purple	fine			well	2	maybe	2
42	Cf	Grasshopper Creek	09S	11W	11	D		45.06281	-112.9108	TRS	NAD	27		Sandstone: purple to buff	medium				3	maybe	2
43	Cf	Grasshopper Creek	09S	11W	11	D		45.06281	-112.9108	TRS	NAD	27		Quartzite sandstone: purple - pink - tan	medium to coarse				15	maybe	2
44	Cf	Grasshopper Creek	09S	11W	11	D		45.06281	-112.9108	TRS	NAD	27		Quartzite sandstone: lenses and beds of pebbles	coarse to pebbly			poorly	13.5	maybe	2
45	Cf	Kate Creek					On ridge between right and left fork of Kate Creek about 6 miles from Ike Rife Ranch near junction of Kate and Medicine Lodge Creeks, Beaverhead County					27		Sandstone: with irregular masses and layers of medium gray quartzite, partially covered, light gray	fine to pebbly	chert in areas, friable in others		poorly	54	maybe	2
46	Cf	Ashbrough Canyon	09S	08W	27		North Side of Ashbrough Canyon on west side of Blacktail Deer Creek valley, about 15 miles south of Dillon MT. sec 27,T. 9 S., R. 8 W., Beaverhead County	45.02141	-112.569	TRS	NAD	27		Sandstone: cross-bedded, white and light gray	medium and coarse			poorly	23	maybe	2
47	Cf	Ashbrough Canyon	09S	08W	27			45.02141	-112.569	TRS	NAD	27		Sandstone: medium to thick bedded, lighter and finer toward top, cross bedding	medium to coarse				27	maybe	2

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48	Cf	Ashbrough Canyon	09S	08W	27			45.02141	-112.569	TRS	NAD	27		Sandstone: arkosic, purplish to reddish gray			scattered angular quartz pebbles	poorly	6	no	2
49	Cf	Camp Creek	2S	08W	20		4 miles East of Melrose, in sec. . 20, T. 2 S., R. 8 W.	45.64885	-112.6194	TRS	NAD	28		Quartzitic sandstone: medium bedded, purplish gray, most of unit interbedded with shale					7	no	2
50	Cf	Camp Creek	2S	08W	20			45.64885	-112.6194	TRS	NAD	28		Quartzite: massive to thin bedded brownish gray					25	no	2
51	Cf	Sheep Mountain	08S	03W			2 miles east of fork on South Fork of Green Horn Creek, T. 8 S., R. 3 W., Madison county					30		Quartzite: brownish gray, rusty when weathered					103	no	2
52	Cf	Whitetail Valley	02N	04W	11		5 miles northeast of Whitehall, sec. 11, T. 2 N., R. 4 W.	45.9403	-112.0673	TRS	NAD	30		Quartzite: light-gray and pinkish gray, followed by covered material	medium				12	no	2
53	Cf	Whitetail Valley	02N	04W	11			45.9403	-112.0673	TRS	NAD	30		Quartzite sandstone: pinkish to brownish gray	medium				9	no	2
54	Cf	Helena					ridge east of first gate on Nelson Gulch 6 miles west of Helena					31		Quartzite: medium bedded, gray, pinkish/brownish/purplish gray, followed by 38 (ft) quartzite talus	medium				81	no	2
55	Cf	South Boulder	01S	03W	21		west side of South Boulder Creek sec. 21, T. 1 S., R. 3 W., Madison County	45.73482	-111.9778	TRS	NAD	33		Sandstone: medium bedded, light gray, pinkish and tan-gray, rusty stains	medium to coarse			poorly	40	maybe	2
56	Cf	South Boulder	01S	03W	21			45.73482	-111.9778	TRS	NAD	33		Sandstone: medium bedded, brown and purplish gray, then pinkish gray to tan	medium	hard			17	maybe	2
57	Cf	Wigwam Creek	07S	02W	36		S 1/2 sec. 36, T.7S., R. 2W., and N 1/2 sec. 1, T. 8 S., R. 2 W.	45.18169	-111.7916	TRS	NAD	34		Sandstone: arkosic with two pebble beds, reddish brown to gray, followed by shale	coarse			poorly	16	no	2
58	Cf	Wigwam Creek	07S	02W	36			45.18169	-111.7916	TRS	NAD	34		Quartzite: some pebbly layers and thinly laminated sandstone, highly crossbedded, reddish brown to brownish gray				poorly	13	no	2
59	Cf	Wigwam Creek	07S	02W	36			45.18169	-111.7916	TRS	NAD	34		Sandstone: some quartzite layers, basal unconformity, reddish-brown to tan	medium				14	maybe	2
60	Cf	Wigwam Creek	08S	02W	1		S 1/2 sec. 36, T.7S., R. 2W., and N 1/2 sec. 1, T. 8 S., R. 2 W.	45.16716	-111.7917	TRS	NAD	34		Sandstone: arkosic with two pebble beds followed by shale, reddish brown to gray	coarse			poorly	16	no	2
61	Cf	Wigwam Creek	08S	02W	1			45.16716	-111.7917	TRS	NAD	34		Quartzite: some pebbly layers and thinly laminated sandstone, highly crossebedded, reddish brown to brownish gray.				poorly	13	no	2
62	Cf	Wigwam Creek	08S	02W	1			45.16716	-111.7917	TRS	NAD	34		Sandstone: some quartzite layers, basal unconformity, reddish-brown to tan	medium				14	maybe	2
63	Cf	Townsend	07N	01E	34		3 miles due west of Townsend, S 1/2sec. 34, T. 7 N., R. 1 E.	46.319	-111.5881	TRS	NAD	35		Quartzite and micaceous argillite (4:1), presence of impure sandstone, fine grained sills present					71	no	2
64	Cf	Townsend	07N	01E	34			46.319	-111.5881	TRS	NAD	35		Quartzite: vitreous, cross-bedded, ridge forming	fine to coarse		well rounded quartz, angular flat argillite (pebbles)	poorly	92	no	2
65	Cf	White Sulphur Springs	08N	07E	32		10 miles south of White Sulphur Springs sec. 32, T. 8 N., R. 7 E.	46.41064	-110.878	TRS	NAD	36		Rusty gray quartzitic sandstone	coarse				7	maybe	2
66	Cf	White Sulphur Springs	08N	07E	32			46.41064	-110.878	TRS	NAD	36		Rusty gray quartzitic sandstone, but mostly covered	coarse				46	maybe	2

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67	Cf	White Sulphur Springs	08N	07E	32			46.41064	-110.878	TRS	NAD	36		Sandstone: locally quartzitic, thin to medium bedded, pale pinkish gray to rusty gray	medium to coarse			poorly	38	maybe	2
68	Cf	White Sulphur Springs	08N	07E	32			46.41064	-110.878	TRS	NAD	36		Quartzite with some sandstone: bedded, well exposed cliff, brown to flesh colored	coarse			medium	45	no	2
69	Cf	Logan	02N	02E	36		North Side of Gallatin River near Logan, Gallatin County	45.88178	-111.4196	TRS	NAD	37		Sandstone and quartzite: light gray and light pinkish	medium -fine				20	maybe	2
70	Cf	Logan	02N	02E	36			45.88178	-111.4196	TRS	NAD	37		Sandstone and quartzite: medium to thick bedded, light purple and tan-gray	coarse up to 3/8 "			poorly	11	maybe	2
71	Cf	Logan	02N	02E	36			45.88178	-111.4196	TRS	NAD	37		Quartzite: medium bedded, flesh colored to light brown	medium				6	maybe	2
72	Cf	Logan	02N	02E	36			45.88178	-111.4196	TRS	NAD	37		Quartzite: thick bedded, purplish	medium				4	no	2
73	Cf	Logan	02N	02E	36			45.88178	-111.4196	TRS	NAD	37		Sandstone: buff and pinkish buff					3	maybe	2
74	Cf	Logan	02N	02E	36			45.88178	-111.4196	TRS	NAD	37		Quartzite and sandstone: medium interbedded	medium to fine				9	maybe	2
75	Cf	Logan	02N	02E	36			45.88178	-111.4196	TRS	NAD	37		Quartzite	medium				2	no	2
76	Cf	Logan	02N	02E	36			45.88178	-111.4196	TRS	NAD	37		Sandstone and quartzite					5	no	2
77	Cf	Jourdain Creek	05S	01E	22		sec. 22 & 23, T. 5 S., R. 1 E., 8 miles NE of Ennis	45.3864	-111.5869	TRS	NAD	38		Quartzite and sandstone: argillaceous at top, thin to thick bedded, purplish-gray	medium to coarse				98	maybe	2
78	Cf	Jourdain Creek	05S	01E	23		sec. 22 & 23, T. 5 S., R. 1 E., 8 miles NE of Ennis	45.38619	-111.5663	TRS	NAD	38		Quartzite and sandstone: argillaceous at top, thin to thick bedded, purplish-gray	medium to coarse				98	maybe	2
79	Cf	Arrowhead Mountain	14S	01W	28		sec. 28, T. 14 S., R. 1 W.	44.58506	-111.7302	TRS	NAD	39		Sandstone and pebbly sandstone: in soil (covered), brown and pinkish	pebbles				75	no	2
80	Cf	Cooke City	09S	14E	25	D	SE 1/4 sec. 25, T. 9 S., R. 14 E.	45.01597	-109.9257	TRS	NAD	40		Sandstone interbedded with argillaceous sandstone and arenaceous shale	fine				36	no	2
81	Cf	Cooke City	09S	14E	25	D		45.01597	-109.9257	TRS	NAD	40		Sandstone: thin to thick bedded tan - gray, some fine grained, purplish	medium to coarse				75	maybe	2
82	Cf	Cooke City	09S	14E	25	D		45.01597	-109.9257	TRS	NAD	40		Sandstone	fine to medium					maybe	2
83	Cf	Belt Creek	15N	07E	14	A	Belt Creek 8 miles S. of Monarch, NE. 1/4 sec. 14, the SW. 1/4 sec. 13, the N. 1/2 sec. 24, and the SE. 1/4 sec. 25, T. 15 N., R. 7 E.	47.06353	-110.7984	TRS	NAD	285		Quartzite, white					1.5	no	3
84	Cf	Belt Creek	15N	07E	14	A		47.06353	-110.7984	TRS	NAD	285		Sandstone: rust, rotten					5	maybe	3
85	Cf	Belt Creek	15N	07E	14	A		47.06353	-110.7984	TRS	NAD	285		Sandstone: flaggy, dirty white to buff					15	no	3
86	Cf	Belt Creek	15N	07E	14	A		47.06353	-110.7984	TRS	NAD	285		Sandstone: fissile, impure, purple, rust colored					30	no	3
87	Cf	Belt Creek	15N	07E	14	A		47.06353	-110.7984	TRS	NAD	285		Quartzite: flaggy					6	no	3
88	Cf	Belt Creek	15N	07E	14	A		47.06353	-110.7984	TRS	NAD	285		Quartzite: vitreous, hard, massive, knotty,					60	no	3
89	Cf	Belt Creek	15N	07E	14	A		47.06353	-110.7984	TRS	NAD	285		Sandstone: dark red and ferruginous						maybe	3
90	Cf	Belt Creek	15N	07E	13	C	Belt Creek 8 miles S. of Monarch, NE. 1/4 sec. 14, the SW. 1/4 sec. 13, the N. 1/2 sec. 24, and the SE. 1/4 sec. 25, T. 15 N., R. 7 E.	47.05622	-110.788	TRS	NAD	285		Quartzite: white					1.5	no	3
91	Cf	Belt Creek	15N	07E	13	C		47.05622	-110.788	TRS	NAD	285		Sandstone: rust, rotten					5	maybe	3
92	Cf	Belt Creek	15N	07E	13	C		47.05622	-110.788	TRS	NAD	285		Sandstone: flaggy, dirty white to buff					15	no	3

sectionId	Unit Symbol	Measured Section Name	TWP	Rng	Sec	Qsec	Loc Notes	Lat (Apprx)	Long (Apprx)	method	Horizontal Datum	Page Num	Sub Unit Id	Description	Grain Size	Cementation	Roundness	Sorting	Thick Ft	Suitability?	Ref Id
93	Cf	Belt Creek	15N	07E	13	C		47.05622	-110.788	TRS	NAD	285		Sandstone: fissile, impure, purple, rust-colored					30	no	3
94	Cf	Belt Creek	15N	07E	13	C		47.05622	-110.788	TRS	NAD	285		Quartzite: flaggy					6	no	3
95	Cf	Belt Creek	15N	07E	13	C		47.05622	-110.788	TRS	NAD	285		Quartzite: vitreous, hard, massive, knotty,					60	no	3
96	Cf	Belt Creek	15N	07E	13	C		47.05622	-110.788	TRS	NAD	285		Sandstones: dark red and ferruginous						maybe	3
97	Cf	Belt Creek	15N	07E	24		Belt Creek 8 miles S. of Monarch, NE. 1/4 sec. 14, the SW. 1/4 sec. 13, the N. 1/2 sec. 24, and the SE. 1/4 sec. 25, T. 15 N., R. 7 E.	47.0454	-110.7827	TRS	NAD	285		Quartzite: white					1.5	no	3
98	Cf	Belt Creek	15N	07E	24			47.0454	-110.7827	TRS	NAD	285		Sandstone: rust, rotten					5	maybe	3
99	Cf	Belt Creek	15N	07E	24			47.0454	-110.7827	TRS	NAD	285		Sandstone: dirty white to buff, flaggy					15	no	3
100	Cf	Belt Creek	15N	07E	24			47.0454	-110.7827	TRS	NAD	285		Sandstone: fissile, impure, purple, rust colored					30	no	3
101	Cf	Belt Creek	15N	07E	24			47.0454	-110.7827	TRS	NAD	285		Quartzite: flaggy					6	no	3
102	Cf	Belt Creek	15N	07E	24			47.0454	-110.7827	TRS	NAD	285		Quartzite: vitreous, hard, massive, knotty					60	no	3
103	Cf	Belt Creek	15N	07E	24			47.0454	-110.7827	TRS	NAD	285		Sandstone: dark red and ferruginous						maybe	3
104	Cf	Belt Creek	15N	07E	25	D	Belt Creek 8 miles S. of Monarch, NE. 1/4 sec. 14, the SW. 1/4 sec. 13, the N. 1/2 sec. 24, and the SE. 1/4 sec. 25, T. 15 N., R. 7 E.	47.0272	-110.7772	TRS	NAD	285		Quartzite: white					1.5	no	3
105	Cf	Belt Creek	15N	07E	25	D		47.0272	-110.7772	TRS	NAD	285		Sandstone: rust, rotten					5	maybe	3
106	Cf	Belt Creek	15N	07E	25	D		47.0272	-110.7772	TRS	NAD	285		Sandstone: dirty white to buff, flaggy					15	maybe	3
107	Cf	Belt Creek	15N	07E	25	D		47.0272	-110.7772	TRS	NAD	285		Sandstone: fissile, impure, purple, rust colored					30	maybe	3
108	Cf	Belt Creek	15N	07E	25	D		47.0272	-110.7772	TRS	NAD	285		Quartzite: flaggy					6	no	3
109	Cf	Belt Creek	15N	07E	25	D		47.0272	-110.7772	TRS	NAD	285		Quartzite: vitreous, hard, massive, knotty,					60	no	3
110	Cf	Belt Creek	15N	07E	25	D		47.0272	-110.7772	TRS	NAD	285		Sandstone: dark red and ferruginous						maybe	3
111	IPMs	Utica					North Side of Judith River near Utica					297		Sandstone: granular, friable, soft-rock with massive, round weathering outcrop.					10	yes	3
112	Cf	Belt Creek	15N	07E	14	A	5.25 miles S. 35 degrees E of Monarch. NE. 1/4 sec. 14, the SW. 1/4 sec. 13, the N. 1/2 sec. 24, and the SE. 1/4 sec. 25, T. 15 N., R. 7 E.	47.06353	-110.7984	TRS	NAD	1271		Quartzitic sandstone: micaceous, thin bedded but massive; quartz pebbles in lenses, tan-buff and red				poorly	108	maybe	4
113	Cf	Belt Creek	15N	07E	14	A		47.06353	-110.7984	TRS	NAD	1271		Quartz sandstone: pure, vitreous, massive, brown, tan-red	coarse grained - pebbles		rounded		88	maybe	4
114	Cf	Belt Creek	15N	07E	14	A		47.06353	-110.7984	TRS	NAD	1271		Sandstone: lithic, hematitic, quartz pebbles in upper 5 ft, massive, red to tan	coarse				10	no	4
115	Cf	Belt Creek	15N	07E	13	C	5.25 miles S. 35 degrees E of Monarch. NE. 1/4 sec. 14, the SW. 1/4 sec. 13, the N. 1/2 sec. 24, and the SE. 1/4 sec. 25, T. 15 N., R. 7 E.	47.05622	-110.788	TRS	NAD	1271		Quartzitic sandstone: micaceous, thin bedded but massive, tan-buff and red.				poorly	108	maybe	4
116	Cf	Belt Creek	15N	07E	13	C		47.05622	-110.788	TRS	NAD	1271		Quartz sandstone: massive, pure, vitreous, massive, brown, tan-red	coarse grained - pebbles		rounded		88	maybe	4
117	Cf	Belt Creek	15N	07E	13	C		47.05622	-110.788	TRS	NAD	1271		Sandstone: lithic, hematitic, quartz pebbles in upper 5 ft, massive, red to tan	coarse				10	no	4

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118	Cf	Belt Creek	15N	07E	24		5.25 miles S. 35 degrees E of Monarch. NE. 1/4 sec. 14, the SW. 1/4 sec. 13, the N. 1/2 sec. 24, and the SE. 1/4 sec. 25, T. 15 N., R. 7 E.	47.0454	-110.7827	TRS	NAD	1271		Quartzitic sandstone: micaceous, thin bedded but massive, quartz pebbles in lenses,tan-buff and red				poorly	108	maybe	4
119	Cf	Belt Creek	15N	07E	24			47.0454	-110.7827	TRS	NAD	1271		Sandstone: massive, pure, vitreous, brown, tan-red, massive quartz sandstone, pure, vitreous	coarse grained-pebbles		rounded		88	maybe	4
120	Cf	Belt Creek	15N	07E	24			47.0454	-110.7827	TRS	NAD	1271		Sandstone: lithic, hematitic, quartz pebbles in upper 5 ft, massive, red to tan	coarse				10	maybe	4
121	Cf	Belt Creek	15N	07E	25	D	5.25 miles S. 35 degrees E of Monarch. NE. 1/4 sec. 14, the SW. 1/4 sec. 13, the N. 1/2 sec. 24, and the SE. 1/4 sec. 25, T. 15 N., R. 7 E.	47.0272	-110.7772	TRS	NAD	1271		Quartzitic sandstone: micaceous, thin bedded but massive, quartz pebbles in lenses				poorly	108	maybe	4
122	Cf	Belt Creek	15N	07E	25	D		47.0272	-110.7772	TRS	NAD	1271		Quartz sandstone: pure, vitreous, massive, brown, tan-red	coarse grained-pebbles		rounded		88	maybe	4
123	Cf	Belt Creek	15N	07E	25	D		47.0272	-110.7772	TRS	NAD	1271		Sandstone: lithic, hematitic, massive, quartz pebbles in upper 5 ft, red to tan, massive	coarse				10	maybe	4
124	Cf	Dearborn River-Monitor Mountain	17N	04W	6		S. 35 degrees E. of Steamboat Mountain, sec. 6 & 7; 31 & 32, T. 17 & 18 N., R. 4 & 8 W.	47.25708	-112.162	TRS	NAD	34		Quartzite: compact, massive, quartz pebbles, white/gray, sandy, massive, compact, limonite, quartz pebbles	coarse			poorly	26	no	5
125	Cf	Dearborn River-Monitor Mountain	17N	04W	6			47.25708	-112.162	TRS	NAD	34		Sandstone: white/gray, calcareous, thick and thin bedded, interbedded with coarse grained/cross bedded quartzitic sandstone	fine to pebbly			poorly	5	no	5
126	Cf	Dearborn River-Monitor Mountain	17N	04W	6			47.25708	-112.162	TRS	NAD	34		Quartzite: massive, limonitic, cross-bedded, thick and thin bedded, tiny quartz pebbles distributed unevenly, lower portions more limonite and shaly	coarse			medium	48	no	5
127	Cf	Dearborn River-Monitor Mountain	17N	04W	6			47.25708	-112.162	TRS	NAD	34		Quartzite: vitreous, massive, cross bedded, thick bedded, pure, irregular limonite and quartz pebbles	coarse			poorly	5.7	no	5
128	Cf	Dearborn River-Monitor Mountain	17N	08W	7		S. 35 degrees E. of Steamboat Mountain, sec. 6 & 7; 31 & 32, T. 17 & 18 N., R. 4 & 8 W.	47.2413	-112.6698	TRS	NAD	34		Quartzite: white/gray, sandy, massive, compact, limonite, quartz pebbles	coarse			poorly	26	no	5
129	Cf	Dearborn River-Monitor Mountain	17N	08W	7			47.2413	-112.6698	TRS	NAD	34		Sandstone: white/gray, calcareous, thick and thin bedded, interbedded with coarse grained/ cross bedded quartzitic sandstone	fine to pebbly			poorly	5	no	5
130	Cf	Dearborn River-Monitor Mountain	17N	08W	7			47.2413	-112.6698	TRS	NAD	34		Quartzite: massive, limonitic, cross-bedded, thick and thin bedded, tiny quartz pebbles distributed unevenly, lower portions more limonite and shaly	coarse			medium	48	no	5
131	Cf	Dearborn River-Monitor Mountain	17N	08W	7			47.2413	-112.6698	TRS	NAD	34		Quartzite: massive, cross bedded, thick bedded, pure, vitreous, irregular limonite and quartz pebbles	coarse			poorly	5.7	no	5
132	Cf	Dearborn River-Monitor Mountain	18N	04W	31		S. 35 degrees E. of Steamboat Mountain, sec. 6 & 7; 31 & 32, T. 17 & 18 N., R. 4 & 8 W.	47.27145	-112.1623	TRS	NAD	34		Quartzite: white/gray, sandy, massive, limonite, quartz pebbles	coarse			poorly	26	no	5
133	Cf	Dearborn River-Monitor Mountain	18N	04W	31			47.27145	-112.1623	TRS	NAD	34		Sandstone: white/gray, calcareous, thick and thin bedded, interbedded with coarse grained/cross bedded quartzitic sandstone	fine to pebbly			poorly	5	no	5

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134	Cf	Dearborn River-Monitor Mountain	18N	04W	31			47.27145	-112.1623	TRS	NAD	34		Quartzite: massive, limonitic, cross-bedded, thick and thin bedded, tiny quartz pebbles distributed unevenly, lower portions more limonite and shaly	coarse			medium	48	no	5
135	Cf	Dearborn River-Monitor Mountain	18N	04W	31			47.27145	-112.1623	TRS	NAD	34		Quartzite: massive, cross bedded, thick bedded, pure, vitreous, irregular limonite and quartz pebbles	coarse			poorly	5.7	no	5
136	Cf	Dearborn River-Monitor Mountain	18N	08W	32		S. 35 degrees E. of Steamboat Mountain, sec. 6 & 7; 31 & 32, T. 17 & 18 N., R. 4 & 8 W.	47.27057	-112.6486	TRS	NAD	34		Quartzite: white/gray, sandy, massive, compact, limonite, quartz pebbles	coarse			poorly	26	no	5
137	Cf	Dearborn River-Monitor Mountain	18N	08W	32			47.27057	-112.6486	TRS	NAD	34		Sandstone: white/gray, calcareous, thick and thin bedded, interbedded with coarse grained/ cross bedded quartzitic sandstone	fine to pebbly			poorly	5	no	5
138	Cf	Dearborn River-Monitor Mountain	18N	08W	32			47.27057	-112.6486	TRS	NAD	34		Quartzite: massive, limonitic, cross-bedded, thick and thin bedded, tiny quartz pebbles distributed unevenly, lower portions more limonite and shaly	coarse			medium	48	no	5
139	Cf	Dearborn River-Monitor Mountain	18N	08W	32			47.27057	-112.6486	TRS	NAD	34		Quartzite: massive, cross bedded, thick bedded, pure, vitreous, irregular limonite and quartz pebbles	coarse			poorly	5.7	no	5
140	lPdp	Stonehouse Canyon section	11N	20E	25		sec. 25, T. 11 N., R. 20 E.	46.68591	-109.1478	TRS	NAD	28	4	Sandstone: friable (top 6 ft), white-mottled gray and pink, poorly bedded, clean	medium	friable (top 6 ft), porous, noncalcareous		well	18	yes	6
141	Mk	section 29. Nelson Ranch	12N	20E	8		S1/2, sec. 8, T.12N., R.20E.	46.81632	-109.2327	TRS	NAD	188	30	Sandstone: friable, white	medium	friable		poorly	1	maybe	7
142	Mk	section 29. Nelson Ranch	12N	20E	8			46.81632	-109.2327	TRS	NAD	188	34	Sandstone: white, cross bedded	medium	poorly indurated		poorly	9	yes	7
143	Mk	section 30. Menard Ridge	13N	19E	36		S1/4, sec. 36, T.13N., R.19E.	46.84452	-109.2586	TRS	NAD	191	40	Sandstone: clean, white, tan-weathering	fine	poorly indurated			6	yes	7
144	Mk	section 30. Menard Ridge	13N	19E	36			46.84452	-109.2586	TRS	NAD	191	44	Sandstone: sugary, thin bedded, red brown speckled, very light tan with white weathering	fine				7	yes	7
145	Mk	section 30. Menard Ridge	13N	19E	36			46.84452	-109.2586	TRS	NAD	191	48	Sandstone: thin bedded and fissile, downward gradation to silt, white, reddish weathering				moderate	5.5	yes	7
146	Mk	section 54. Stonehouse Canyon	11N	20E	15	A	NE1/4, sec. 15 and 36, T.11N., R.20E.	46.71894	-109.1847	TRS	NAD	243	54	Sandstone: tan, light gray weathering	fine to medium	well indurated, calcite			5	maybe	7
147	Mk	section 54. Stonehouse Canyon	11N	20E	36		NE1/4, sec. 15 and 36, T.11N.,R.20E.	46.6716	-109.1478	TRS	NAD	243	54	Sandstone: tan, light gray weathering	fine to medium	well indurated, calcite			5	maybe	7
148	Mk	section 56. Durfee Creek Dome	12N	22E	13	D	SE1/4, sec. 13, T.12N.,R.22E.	46.7971	-108.8878	TRS	NAD	247	40	Sandstone: tan	fine	poorly indurated			8	yes	7
149	Mk	section 56. Durfee Creek Dome	12N	22E	13	D		46.7971	-108.8878	TRS	NAD	247	42	Sandstone: thin bedded, cross bedded, tan				moderate	4	maybe	7
150	Mk	section 56. Durfee Creek Dome	12N	22E	13	D		46.7971	-108.8878	TRS	NAD	247	44	Sandstone: topped with porous dolomite	fine	calcareous			4	maybe	7
151	Mk	section 56. Durfee Creek Dome	12N	22E	13	D		46.7971	-108.8878	TRS	NAD	247	47	Sandstone	medium	calcareous			4	maybe	7
152	Mk	section 56. Durfee Creek Dome	12N	22E	13	D		46.7971	-108.8878	TRS	NAD	247	49	Quartzitic sandstone: maroon and white		poorly indurated		poorly	7	maybe	7

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153	Mk	section 56. Durfee Creek Dome	12N	22E	13	D		46.7971	-108.8878	TRS	NAD	247	51	Sandstone: pink, tan weathering	medium	calcareous, moderately indurated		moderately well to poorly	12	maybe	7
154	Kv	section 1. St. Mary River Formation, Montana Group	17N	05W	21	CCA	NE1/4 SW 1/4 SW 1/4 sec. 21, T. 17 N., R. 5 W.	47.20892	-112.2532	TRS	NAD	12	7	Sandstone: crossbedded, light-greenish to yellow-gray, weathers buff, upper part has magnetite-rich hard sandstone (cap rock), upper part of unit fossiliferous	medium	limy			38	no	8
155	Kv	section 1. St. Mary River Formation, Montana Group	17N	05W	21	CCA		47.20892	-112.2532	TRS	NAD	12	5	Sandstone: crossbedded, biotitic, medium bedded and locally cross-bedded, light-greenish to yellow-gray, weathers buff	medium	limy			60	no	8
156	Kv	section 1. St. Mary River Formation, Montana Group	17N	05W	21	CCA		47.20892	-112.2532	TRS	NAD	12		Sandstone: thin to massive bedded, a few shaly partings, lower part poorly exposed, light gray	fine to medium				65	mno	8
157	Kjr	section 2. Miner Creek Formation, Meagher County	07N	09E	17	BC	SW1/4 NW 1/4 to the NE 1/4 NE 1/4 sec. 17, T. 7 N., R. 9 E	46.36875	-110.6361	TRS	NAD	25	13	Sandstone: salt and pepper, local placer-like accumulations of dark, heavy mineral grains, light gray	fine to medium				50	no	8
158	Kjr	section 2. Miner Creek Formation, Meagher County	07N	09E	17	AA	SW1/4 NW 1/4 to the NE 1/4 NE 1/4 sec. 17, T. 7 N., R. 9 E	46.37241	-110.6202	TRS	NAD	25	13	Sandstone: salt and pepper, local placer-like accumulations of dark, heavy mineral grains, light gray	fine to medium				50	no	8
159	Ke	section 2. Miner Creek Formation, Meagher County	06N	08E	16	AD	SE 1/4 NE 1/4 sec. 16, T. 6 N., R. 8 E.	46.28196	-110.7243	TRS	NAD	26	7	Sandstone: contains 4 hard layers of dark concretionary sandstone, capped with 3 ft of white sandstone, pale-olive to light-gray,	fine to medium	soft			73	no	8
160	Ke	section 2. Miner Creek Formation, Meagher County	06N	08E	16	AD		46.28196	-110.7243	TRS	NAD	27	4	Sandstone: clayey, light gray		soft			20	no	8
161	Kv	section 2. Miner Creek Formation, Meagher County	06N	08E	16	AD		46.28196	-110.7243	TRS	NAD	28	3	Sandstone: massive, contains lense of olive green andesitic sandstone; capped by 5.5 ft of magnetite-rich sandstone; also contains limy irregular masses and concretions of brown-weathered sandstone, light gray	fine				120	no	8
162	Kjr	section 3.	06N	16E	18		center sec. 18, T. 6 N., R. 16E.	46.2698	-109.7688	TRS	NAD	35	34	Sandstone: thin and crossbedded, forms ridges in upper and middle part followed by softer greenish clayey sandstone and sandy claystone. Dinosaur bone fragments. Forms prominent parallel ridges, greenish gray	fine to medium	calcareous			30	no	8
163	Kjr	section 3.	06N	16E	18			46.2698	-109.7688	TRS	NAD	35	33	Sandstone: crossbedded, 3 ridges separated by argillaceous siltstone, light greenish gray	fine	calcareous			65	no	8
164	Kjr	section 3.	06N	16E	18			46.2698	-109.7688	TRS	NAD	36	31	Sandstone: yellowish-gray, poorly exposed	fine to medium	calcareous, soft			55	no	8
165	Kjr	section 3.	06N	16E	18			46.2698	-109.7688	TRS	NAD	36	30	Sandstone: massive, crossbedded, yellowish gray, contains *Ophiomorpha*	fine	calcareous			30	no	8
166	Kjr	section 3.	06N	16E	18			46.2698	-109.7688	TRS	NAD	36	29	Sandstone: thin bedded, ripple marked, contains thin beds of silty shale in upper part; rare limestone concretions in middle, lower part forms persistent ledge, yellowish gray	fine	calcareous			50	no	8
167	Ke	section 3.	06N	16E	18			46.2698	-109.7688	TRS	NAD	37	20	Sandstone: thin bedded, hard-ridge former, few small clay pebbles, pale yellowish gray	medium to coarse				10	no	8
168	Kv	section 3.	06N	15E	14	A	NE 1/4 sec. 14, T. 6 N., R. 15 E.	46.27315	-109.8048	TRS	NAD	39	6	Sandstone: thin to medium even bedded, lots of borings and *Ophiomorpha*, appears andesitic in part, white in upper part, light olive gray in lower part	fine to medium	non-calcareous			73	no	8

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169	Kle	section 4	06N	22E	23	D	SE 1/4 sec. 23, T. 6 N., R. 22 E.	46.2519	-108.9306	TRS	NAD	43	69	Sandstne: pale yellowish gray, cross bedded, hard ledge former	medium to coarse				1.5	no	8
170	Kle	section 4	06N	22E	23	D		46.2519	-108.9306	TRS	NAD	44	68	Sandstone: thin bedded, ripple marked, lots of *Ophiomorpha,* pale yellowish gray	very fine grained				15	no	8
171	Kjr	section 4	08N	20E	25	C	SW 1/4 sec. 25, T. 8N., R. 20E.	46.4204	-109.1687	TRS	NAD	55	30	Sandstone: thin bedded, seems andesitic, light brownish gray	fine				5	no	8
172	Kjr	section 4	08N	20E	25	C		46.4204	-109.1687	TRS	NAD	58	21	Sandstone: yellowish-gray, micaceous, thick bedded to massive, crossbedded, borings in lower part, clay pebble conglomerate at top, yellowish gray		calcareous			70	no	8
173	Kjr	section 5	08N	20E	25	C		46.4204	-109.1687	TRS	NAD	58	20	Sandstone: thin-medium bedded, crossbedded, interbedded with shale and soft clayey sandstone, yellowish-gray,	fine	calcareous			30	no	8
174	Kjr	section 6	08N	20E	25	C		46.4204	-109.1687	TRS	NAD	58	19	Sandstone: micaceous, thick bedded to massive, crossbedded, lower part thin bedded with shaly partings, rare borings, honeycomb weathering, yellowish-gray	fine	calcareous			50	no	8
175	IPt	Bear Canyon	09S	26E	3	CD	SE 1/4 SW 1/4 sec. 3, T.9 S., R.26 E.	45.07631	-108.5281	TRS	NAD	6		Sandstone: sandy dolomite, vuggy, parallel laminated, pinkish gray					5	no	9
176	IPt	Bear Canyon	09S	26E	3	CD		45.07631	-108.5281	TRS	NAD	6		Sandstone: high angle trough crossbedding, light gray	fine	non-calcareous		well	10	maybe	9
177	IPt	Bear Canyon	09S	26E	3	CD		45.07631	-108.5281	TRS	NAD	6		Sandstone: cross bedded dune sandstone, burrowed in upper 2 feet, light gray	fine	non-calcareous		well	12	maybe	9
178	IPt	Bear Canyon	09S	26E	3	CD		45.07631	-108.5281	TRS	NAD	6		Sandstone: cross-bedded dune sandstone, light gray	fine	non-calcareous		well	13	maybe	9
179	IPt	Bear Canyon	09S	26E	3	CD		45.07631	-108.5281	TRS	NAD	6		Sandstone: cross-bedded dune sandstone, vertical burrows in upper 3 ft, light gray	very fine	non-calcareous		well	22	no	9
180	IPt	Bear Canyon	09S	26E	3	CD		45.07631	-108.5281	TRS	NAD	7		Sandy dolomite: abundant brown cherty nodules and thin beds, lightr gray					11	no	9
181	IPt	Bear Canyon	09S	26E	3	CD		45.07631	-108.5281	TRS	NAD	7		Sandstone: cross-bedded, limy sandstone, light gray	fine	calcareous		well	10	maybe	9
182	IPt	Bear Canyon	09S	26E	3	CD		45.07631	-108.5281	TRS	NAD	7		Sandstone: friable, limy, parallel laminated, light gray	very fine	calcareous, friable		well	4	no	9
183	IPt	Bear Canyon	09S	26E	3	CD		45.07631	-108.5281	TRS	NAD	7		Sandstone: friable, limy, platy argillaceous siltstone and sandstone at the top, dolomitic, light gray	very fine	cacareous, friable		well	2	no	9
184	IPt	Bear Canyon	09S	26E	3	CD		45.07631	-108.5281	TRS	NAD	8		Sandstone: crossbedded, pale, yellowish gray	fine	calcareous		well	3	maybe	9
185	IPt	Bear Canyon	09S	26E	3	CD		45.07631	-108.5281	TRS	NAD	8		Sandstone: very limy sandstone, burrowed upper half, pale yellowish gray	fine to very fine	very calcareous	angular to sub rounded	poorly to fair	6	maybe	9
186	IPt	Bear Canyon	09S	26E	3	CD		45.07631	-108.5281	TRS	NAD	8		Sandstone: limy, lenticular, with beds 1-2 ft thick. Ripple cross laminated, light yellowish gray	fine	calcareous		well	15	maybe	9
187	IPt	Bear Canyon	09S	26E	3	CD		45.07631	-108.5281	TRS	NAD	9		Sandstone: limy, bioturbated, pale blueish gray	very fine	calcareous		well	2	no	9
188	IPt	Bear Canyon 2	09S	26E	3	CB	NW1/4 SW1/4 sec. 3, T. 9S., R 26E.	45.07996	-108.5333	TRS	NAD	10		Sandstone: clean, bioturbated top of dune, light gray	very fine	calcareous		well	2	no	9
189	IPt	Bear Canyon 3	09S	26E	3	CB		45.07996	-108.5333	TRS	NAD	10		Sandstone: cross bedded dune facies, pale yellowish gray	very fine	calcareous		well	57	no	9

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190	IPt	Bear Canyon 4	09S	26E	3	CB		45.07996	-108.5333	TRS	NAD	10		Sandstone: cross bedded dune facies, thin marine reworked parallel laminated zone at top 6", light gray	fine	calcareous		well	36	maybe	9
191	IPt	Bear Canyon 5	09S	26E	3	CB		45.07996	-108.5333	TRS	NAD	10		Sandstone: limy, bioturbated causing massive appearance, light gray	very fine	very calcareous		well	6	no	9
192	IPt	Bear Canyon 6	09S	26E	3	CB		45.07996	-108.5333	TRS	NAD	10		Sandstone: crossbedded sandstone, dune facies, gray	fine	non-calcareous		well	11	maybe	9
193	IPt	Spring Creek	07S	28E	2	A	NE 1/4 sec. 2, T. 7 S., R 28 E.	45.25384	-108.2399	TRS	NAD	48		Sandstone: very limy, 5% lithic limestone grains floating in calcareous mud matrix, ripple laminated, yellowish brown	very fine	very calcareous		well	3	no	9
194	IPt	Spring Creek	07S	28E	2	A		45.25384	-108.2399	TRS	NAD	48		Sandstone: dune, excellent porosity, crossbedding and top 1 ft bioturbated, very light gray	fine	non-calcareous		well	29	yes	9
195	IPt	Spring Creek	07S	28E	2	A		45.25384	-108.2399	TRS	NAD	48		Quartz sandstone: 5% lithic limestone grains floating in calcareous mud matrix, parallel wavy bedding to bioturbated, grayish orange	very fine	very calcareous		well	5	no	9
196	IPt	Spring Creek	07S	28E	2	A		45.25384	-108.2399	TRS	NAD	50		Sandstone: dune, high angle trough and planar cross bedding, very light gray, stained yellowish gray in part (30%)	fine	non-calcareous to calcareous at base		well	20	yes	9
197	IPt	Spring Creek	07S	28E	2	A		45.25384	-108.2399	TRS	NAD	50		Sandstone: cross bedded, overlain by muddy platy sandstone, very light gray	very fine	non-calcareous		well	5	no	9
198	IPt	Spring Creek	07S	28E	2	A		45.25384	-108.2399	TRS	NAD	50		Sandstone: crossbedded, very light gray	very fine	calcareous		well	9	no	9
199	IPt	Spring Creek	07S	28E	2	A		45.25384	-108.2399	TRS	NAD	50		Sandstone: cross bedded, limy, mostly covered, parallel laminated with vertical bioturbation, grayish orange	very fine	calcareous		well	11	no	9
200	IPq	section A	02N	01W	25	A	NE corner, sec. 25, T 2N, R. 1 W. and into the SE corner of sec. 24.	45.89968	-111.6649	TRS	NAD	126		Quartzitic sandstone: thick bedded, ledge forming, wide range of pale colorful grays which weather yellow	medium to coarse	mix of silica and carbonate	rounded		85	maybe	10
201	IPq	section A	02N	01W	25	A		45.89968	-111.6649	TRS	NAD	126		Sandstone float: mostly covered with a little silty limestone					150	maybe	10
202	IPq	section A	02N	01W	25	A		45.89968	-111.6649	TRS	NAD	126		Sandstone and limestone: sandstone beds a few feet thick. Sandstone ledge 9 ft thick at top. Gradation between the Quadrant and Amsden.					24	no	10
203	Cf	section A	02N	01W	10		sec. 10, T. 1N., R 1W.	45.93994	-111.7111	TRS	NAD	129		Quarzitic sandstone: nearly pure quartz sand tinted with iron oxides, thinly crossbedded, a few conglomerate lentils, ledge forming orange/pink grayish and reddish,	coarse to medium	flaggy, siliceous			9	maybe	10
204	Cf	section A	02N	01W	10			45.93994	-111.7111	TRS	NAD	129		Quarzitic sandstone: nearly pure, coarse-grained quartz sand tinted with iron oxides, thinly crossbedded, a few conglomerate lentils, ledge forming orange/pink grayish and reddish,	coarse	less than above			26	yes	10
205	IPq	section C	3N	2E	29	CC	SW 1/4, SW 1/4, sec. 29, T. 3N., R. 2E. and trends SE to NE1/4, NW1/4, sec. 32, T. 3N., R. 2E.	45.97817	-111.5113	TRS	NAD	132		Sandstone and quartzite: brecciated and sheared, thick bedded with a few thin beds of dark chert					30	no	10
206	IPq	section C	3N	2E	30	CC	SW 1/4, SW 1/4, sec. 29, T. 3N., R. 2E. and trends SE to NE1/4, NW1/4, sec. 32, T. 3N., R. 2E.	45.97782	-111.5309	TRS	NAD83			Quartzitic sandstone: thick-bedded, few grayish yellow limestone beds 1-3 ft thick, white to yellowish gray	medium				100	maybe	10

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207	IPq	section D	01N	01W	34	DB	NW1/4, SE1/4, sec. 34, T. 1N., R. 1W.,	45.79226	-111.7081	TRS	NAD	133		Quartzitic sandstone: thin to thick bedded, includes a few thin beds of white limestone, yellowish gray	medium	mainly quartz, but a little calcareous also			157	maybe	10
208	IPMa	section D	01N	01W	34	DB		45.79226	-111.7081	TRS	NAD	133		Quartzitic and calcareous sandstone, thick bedded, quartz beds contain ovoid mottles, pinkish gray, dark -yellowish orange and pale yellowish-brown.	medium	alternating quartz and calcite			79	maybe	10
209	IPMa	section D	01N	01W	34	DB		45.79226	-111.7081	TRS	NAD	133		Quartzitic sandstone: thick bedded, with a few pebbles of yellowish gray siltstone, yellowish orange	medium	quartz			8	maybe	10
210	Cf	section D	01S	01W	8		E1/2 sec. 8, T. 1S., R. 1W.	45.76491	-111.752	TRS	NAD	135		Quartzitic sandstone: thick bedded, a few thin laminae of yellowish gray hornfelsed shale near the top, low ledge forming, varying color - grayish orange, pink/ grayish and yellow gray	medium to coarse near top	quartz			38	no	10
211	Cf	middle Cambrian strata between head of Rough Draw and crest of Shell Mountain	03S	11E	21	C	SW1/4 sec. 21, T.3 S., R. 11 E.	45.55615	-110.3797	TRS	NAD	394		Quartzite (upper 50 ft)and massive sandstone: thick bedded, hematite and limeonite nodules near bottom, gray/reddish	some granules of quartzite few mm in diameter (basal)				75	no	11
212	Jsw	Ellis Group, south slope of Dry Creek Ridge	02S	10E	26	D	SE /4 sec. 26,T. 2 S., R. 10 E.	45.62907	-110.4524	TRS	NAD	411		Sandstone: light gray, cross bedded, brown weathered, forms ledges, *Gryphaea* shells in many beds, salt and pepper	mostly medium	calcareous, glauconitic			80	no	11
213	Mk	1]Big Snowy Group north of Woodhurst Mountain	14N	11E	2		sec. 2, T. 14 N., R. 11 E.	47.00362	-110.2931	TRS	NAD	420		Sandstone: yellow and yellowish gray,	fine				125	maybe	12
214	IPMt	2] Big Snowy Group and Amsden Formation on the SW side of the Blacktail Hills	15N	11E			sec. 19 and 30, T. 15 N., R. 11 E.					420		Sandstone: friable, thin bedded to massive, light brown		friable			90	yes	12
215	IPMt	2] Big Snowy Group and Amsden Formation on the SW side of the Blacktail Hills	15N	11E								420		Sandstone: friable, massive, light brown		friable			120	yes	12
216	Mk	2] Big Snowy Group and Amsden Formation on the SW side of the Blacktail Hills	15N	11E								421		Sandstone: friable quartz sand in upper part followed by 20 ft of gypsum, mostly covered, basal 25-50 ft is red siltstone, light yellow	fine	friable in upper part			250	maybe	12
217	IPMt	3]Heath Shale and Amsden Formation, Skull Butte Dome	15N	12E	6		sec. 6, T. 15 N., R. 12 E.	47.09084	-110.2523	TRS	NAD	423		Sandstone: arkosic, shell fragments, quartz grains, chert and limestone pebbles, red	coarse				15.5	no	12

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218	IPMt	3]Heath Shale and Amsden Formation, Skull Butte Dome	15N	12E	6			47.09084	-110.2523	TRS	NAD	423		Sandstone: somewhat friable, ferruginous, brown		somewhat friable			5	maybe	12
219	IPMt	4] upper part of Heath Shale and Amsden Formation E. of Lone Tree Creek	16N	10E	3		sec. 3, T. 16 N., R. 10 E.	47.17707	-110.4425	TRS	NAD	426		Sandstone: ferruginous, partly covered, red					38	maybe	12
220	IPMt	4] yupper part of Heath Shale and Amsden Formation E. of Lone Tree Creek	16N	10E	3		sec. 3, T. 16 N., R. 10 E.	47.17707	-110.4425	TRS	NAD	426		Sandstone: friable, cross bedded; ledge forming; white, red and yellow,		friable			60	yes	12
221	IPMt	5] Upper part of Heath Shale and Amsden Formation and lower part of Ellis Group, NW of Surprise Creek	16N	10E	12		sec. 12, T. 16 N., R. 10 E.	47.16265	-110.3996	TRS	NAD	426		Sandstone: cross bedded, ledge forming, red	coarse				62	maybe	12
222	IPMt	6] Amsden Formation S. of Surprise Creek	16N	11E	18		sec. 18, T. 16 N., R. 11 E.	47.14822	-110.3787	TRS	NAD	427		Sandstone: somewhat friable, ferruginous, cross bedded, red and locally mottled with white		somewhat friable			36	maybe	12
223	IPMt	7] upper part of Amsden Formation along Dry Wolf Creek	15N	11E	5		sec. 5, T. 15 N., R. 11 E.	47.09044	-110.3578	TRS	NAD	427		Sandstone: red					3	maybe	12
224	IPMt	7] upper part of Amsden Formation along Dry Wolf Creek	15N	11E	5			47.09044	-110.3578	TRS	NAD	427		Sandstone: ripple marked, yellow with some red shale partings					22	maybe	12
225	IPMt	7] upper part of Amsden Formation along Dry Wolf Creek	15N	11E	5			47.09044	-110.3578	TRS	NAD	427		Sandstone: somewhat friable, massive to cross bedded, ledge forming, yellow to white	medium	somewhat friable			22	yes	12
226	IPMt	7] upper part of Amsden Formation along Dry Wolf Creek	15N	11E	5			47.09044	-110.3578	TRS	NAD	427		Sandstone: beds 0.5-3 ft thick with black shale partings ~4 ft thick, brown					54	no	12
227	IPMt	7] upper part of Amsden Formation along Dry Wolf Creek	15N	11E	5			47.09044	-110.3578	TRS	NAD	427		Sandstone: somewhat friable, massive to crossbedded, brown to white	fine	somewhat friable			34	yes	12
228	IPMt	8] upper part of Heath Shale and the Amsden Formation, NE side of Willow Creek	15N	11E	34		sec. 34 and 35, T. 15 N., R. 11 E.	47.01805	-110.3149	TRS	NAD	428		Sandstone: friable, white to orange		friable			5	yes	12
229	IPMt	8] upper part of Heath Shale and the Amsden Formation, NE side of Willow Creek	15N	11E	34			47.01805	-110.3149	TRS	NAD	428		Sandstone: bedded, white-orange-red color varies rapidly in all directions	medium				64	yes	12
230	IPMt	8] upper part of Heath Shale and the Amsden Formation, NE side of Willow Creek	15N	11E	34			47.01805	-110.3149	TRS	NAD	428		Sandstone: friable, massive, gray		friable			18	yes	12

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231	IPMt	8] upper part of Heath Shale and the Amsden Formation, NE side of Willow Creek	15N	11E	34			47.01805	-110.3149	TRS	NAD	428		Sandstone: weathers into large rough surfaced blocks, brown	medium to coarse				15	maybe	12
232	IPMt	8] upper part of Heath Shale and the Amsden Formation, NE side of Willow Creek	15N	11E	34			47.01805	-110.3149	TRS	NAD	428		Sandstone: locally conglomeratic, hematitic, breaks into angular fragments, red	coarse				38.5	no	12
233	IPMt	8] upper part of Heath Shale and the Amsden Formation, NE side of Willow Creek	15N	11E	35		sec. 34 and 35, T. 15 N., R. 11 E.	47.01818	-110.2937	TRS	NAD	428		Sandstone: friable, white to orange		friable			5	yes	12
234	IPMt	8] upper part of Heath Shale and the Amsden Formation, NE side of Willow Creek	15N	11E	35			47.01818	-110.2937	TRS	NAD	428		Sandstone: bedded, white-orange-red color varies rapidly in all directions	medium				64	yes	12
235	IPMt	8] upper part of Heath Shale and the Amsden Formation, NE side of Willow Creek	15N	11E	35			47.01818	-110.2937	TRS	NAD	428		Sandstone: friable, massive, gray		friable			18	yes	12
236	IPMt	8] upper part of Heath Shale and the Amsden Formation, NE side of Willow Creek	15N	11E	35			47.01818	-110.2937	TRS	NAD	428		Sandstone: brown, weathers into large rough surfaced blocks, brown	medium to coarse				15	maybe	12
237	IPMt	8] upper part of Heath Shale and the Amsden Formation, NE side of Willow Creek	15N	11E	35			47.01818	-110.2937	TRS	NAD	428		Sandstone: locally conglomeratic, hematitic, breaks into angular fragments, red	coarse				38.5	no	12
238	Jsw	9] Ellis Group, Amsden Formation, Otter Formation, on East Buffalo Creek	12N	16E	11		sec. 11 and 14, T. 12 N., R. 16 E.	46.81729	-109.6718	TRS	NAD	428		Sandstone: glauconitic, brown	fine				75	no	12
239	IPMt	9] Ellis Group, Amsden Formation, Otter Formation, on East Buffalo Creek	12N	16E	11			46.81729	-109.6718	TRS	NAD	428		Sandstone: thin bedded, yellowish orange	fine				9	maybe	12
240	IPMt	9] Ellis Group, Amsden Formation, Otter Formation, on East Buffalo Creek	12N	16E	11			46.81729	-109.6718	TRS	NAD	428		Sandstone: grayish orange	very fine				6	no	12
241	IPMt	9] Ellis Group, Amsden Formation, Otter Formation, on East Buffalo Creek	12N	16E	11			46.81729	-109.6718	TRS	NAD	429		Sandstone: grayish orange	very fine				22	no	12

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242	IPMt	9] Ellis Group, Amsden Formation, Otter Formation, on East Buffalo Creek	12N	16E	11			46.81729	-109.6718	TRS	NAD	429		Quartzose sandstone: scattered limonite stains, grayish orange					3	maybe	12
243	Jsw	9] Ellis Group, Amsden Formation, Otter Formation, on East Buffalo Creek	12N	16E	14		sec. 11 and 14, T. 12 N., R. 16 E.	46.80268	-109.6717	TRS	NAD	428		Sandstone: glauconitic, brown	fine				75	no	12
244	IPMt	9] Ellis Group, Amsden Formation, Otter Formation, on East Buffalo Creek	12N	16E	14			46.80268	-109.6717	TRS	NAD	428		Sandstone: thin bedded, yellowish orange	fine				9	maybe	12
245	IPMt	9] Ellis Group, Amsden Formation, Otter Formation, on East Buffalo Creek	12N	16E	14			46.80268	-109.6717	TRS	NAD	428		Sandstone: grayish orange	very fine				6	no	12
246	IPMt	9] Ellis Group, Amsden Formation, Otter Formation, on East Buffalo Creek	12N	16E	14			46.80268	-109.6717	TRS	NAD	429		Sandstone: grayish orange	very fine				22	no	12
247	IPMt	9] Ellis Group, Amsden Formation, Otter Formation, on East Buffalo Creek	12N	16E	14			46.80268	-109.6717	TRS	NAD	429		Quartzose sandstone: scattered limonite stains, grayish orange					3	maybe	12
248	IPMt	10] Upper part of the Otter Formation and the Amsden Formation, exposed on Antelope Creek	12N	16E	9		sec. 9 and 16., T. 12 N., R. 16 E.	46.81739	-109.714	TRS	NAD	429		Sandstone: friable, cross bedded and partly covered, brown and yellow	medium	friable			70	yes	12
249	IPMt	10] Upper part of the Otter Formation and the Amsden Formation, exposed on Antelope Creek	12N	16E	9			46.81739	-109.714	TRS	NAD	429		Sandstone and conglomerate: partly covered, red					110	no	12
250	IPMt	10] Upper part of the Otter Formation and the Amsden Formation, exposed on Antelope Creek	12N	16E	16		sec. 9 and 16., T. 12 N., R. 16 E.	46.80266	-109.714	TRS	NAD	429		Sandstone: friable, cross bedded and partly covered, brown and yellow	medium	friable			70	yes	12
251	IPMt	10] Upper part of the Otter Formation and the Amsden Formation, exposed on Antelope Creek	12N	16E	16			46.80266	-109.714	TRS	NAD	429		Sandstone and conglomerate: red, partly covered					110	no	12
252	Jsw	11] Ellis Group and the upper part of the Amsden Formation on a branch of Wait Creek	13N	12E	1		sec. 1, T. 13 N., R. 12 E.	46.91693	-110.1452	TRS	NAD	433		Sandstone: unfossiliferous, brown	medium				15	no	12

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253	Jsw	11] Ellis Group and the upper part of the Amsden Formation on a branch of Wait Creek	13N	12E	1			46.91693	-110.1452	TRS	NAD	433		Sandstone, gray, cross bedded glauconitic, contains chert pebbles and oyster shells	medium to coarse				20	no	12
254	Jsw	11] Ellis Group and the upper part of the Amsden Formation on a branch of Wait Creek	13N	12E	1			46.91693	-110.1452	TRS	NAD	433		Sandstone: thin bedded, glauconitic, brown	fine to medium				23	no	12
255	IPMt	11] Ellis Group and the upper part of the Amsden Formation on a branch of Wait Creek	13N	12E	1			46.91693	-110.1452	TRS	NAD	434		Sandstone: friable, white	fine	friable			3	yes	12
256	IPMt	11] Ellis Group and the upper part of the Amsden Formation on a branch of Wait Creek	13N	12E	1			46.91693	-110.1452	TRS	NAD	434		Sandstone: friable, bedded, white	fine	friable			18	yes	12
257	IPMt	11] Ellis Group and the upper part of the Amsden Formation on a branch of Wait Creek	13N	12E	1			46.91693	-110.1452	TRS	NAD	434		Sandstone: friable, only top exposed, white.	fine	friable				maybe	12
258	Ke	19]Eagle Sandstone on the West side of the Judith River	18N	16E	6		sec. 6, T. 18 N., R. 16 E.	47.35235	-109.7346	TRS	NAD	447		Sandstone: friable, massive, brown and white		friable			55	yes	12
259	Ke	19]Eagle Sandstone on the West side of the Judith River	18N	16E	6			47.35235	-109.7346	TRS	NAD	447		Sandstone: upper part forms massive white cliff, brown and white					55	yes	12
260	Ke	19]Eagle Sandstone on the West side of the Judith River	18N	16E	6			47.35235	-109.7346	TRS	NAD	447		Sandstone: friable, contains few black chert grains in addition to quartz and forms cliffs, brown and white	fine to medium	friable				maybe	12
261	IPMa	Amsden Formation in canyon near Kane, Wyo., Dry Head, Mont., road.	09S	28E	35		W1/2 sec. 35, T. 9 S., R. 28 E.	45.00826	-108.2606	TRS	NAD	28		Sandstone: cross bedded, ledge forming, light gray	fine	calcareous			4	maybe	13
262	IPt	Amsden Formation about 3 miles south of Bighorn River canyon mouth	06S	31E	33	A	NE1/4 sec. 33, T. 6 S., R. 31 E.	45.27163	-107.9138	TRS	NAD	29		Sandstone: friable, cross-bedded, massive, white, weathers gray to yellowish gray		friable			22	yes	13
263	IPMa	Amsden Formation about 3 miles south of Bighorn River canyon mouth	06S	31E	33	A		45.27163	-107.9138	TRS	NAD	29		Quartzitic sandstone: locally cherty, purplish-brown and white		quartzitic			10	no	13
264	IPMa	Amsden Formation about 3 miles south of Bighorn River canyon mouth	06S	31E	33	A		45.27163	-107.9138	TRS	NAD	29		Sandstone: massive, white to gray, weathers brown		calcareous			3	maybe	13

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265	IPMa	Amsden Formation about 3 miles south of Bighorn River canyon mouth	06S	31E	33	A		45.27163	-107.9138	TRS	NAD	29		Sandstone: massive, nonresistant, dark red with some gray streaks	fine	well- to friable			6	no	13
266	IPMa	Amsden Formation about 3 miles south of Bighorn River canyon mouth	06S	31E	33	A		45.27163	-107.9138	TRS	NAD	29		Sandstone: friable, massive, light reddish brown	medium to fine	friable, very calcareous			11	maybe	13
267	IPMa	Amsden Formation about 3 miles south of Bighorn River canyon mouth	06S	31E	33	A		45.27163	-107.9138	TRS	NAD	29		Sandstone: red	medium to coarse	poorly quartz and sand grains	sub angular	poorly	23	maybe	13
268	IPt	section of Tensleep Sandstone	09S	28E	34		S1/2 sec. 34, T. 9 S., R. 28 E.	45.00828	-108.2809	TRS	NAD	31		Sandstone: thin bedded, ledge forming, thin lenses of calcite in upper part, yellowish brown, weathers brown		calcareous			14	maybe	13
269	IPt	section of Tensleep Sandstone	09S	28E	34			45.00828	-108.2809	TRS	NAD	31		Sandstone: friable, clean, cross-bedded, white, weathers light gray and nodular	fine	porous, friable	well rounded		13	yes	13
270	IPt	section of Tensleep Sandstone	09S	28E	34			45.00828	-108.2809	TRS	NAD	31		Sandstone: porous, slabby, eroded significantly to the north, brown.	medium	calcareous, porous			8	yes	13
271	IPt	section of Tensleep Sandstone	09S	28E	34			45.00828	-108.2809	TRS	NAD	32		Sandstone: friable, white, weathers light gray	fine	friable			4	yes	13
272	IPt	section of Tensleep Sandstone	09S	28E	34			45.00828	-108.2809	TRS	NAD	32		Sandstone: brown	fine	calcareous			2	maybe	13
273	IPt	section of Tensleep Sandstone	09S	28E	34			45.00828	-108.2809	TRS	NAD	32		Sandstone: medium bedded and cross bedded, nodular, ledge forming, white to light gray					6	no	13
274	IPt	section of Tensleep Sandstone	09S	28E	34			45.00828	-108.2809	TRS	NAD	32		Sandstone: light-greenish gray, mostly covered		calcareous, soft, platy			1	maybe	13
275	IPt	section of Tensleep Sandstone	09S	28E	34			45.00828	-108.2809	TRS	NAD	32		Sandstone: porous, cross bedded, white, weathers gray	medium	porous			3	yes	13
276	IPt	section of Tensleep Sandstone	09S	28E	34			45.00828	-108.2809	TRS	NAD	32		Sandstone: upper part forms ledge while lower is covered, light-brown gray	fine				6	maybe	13
277	IPt	section of Tensleep Sandstone	09S	28E	34			45.00828	-108.2809	TRS	NAD	32		Sandstone: ledge forming, light gray, weathers brown	medium	variable calcareous locally quartzitic			4	maybe	13
278	IPt	section of Tensleep Sandstone	09S	28E	34			45.00828	-108.2809	TRS	NAD	32		Sandstone: thick bedded, nodular, light gray	fine to medium	calcareous			11	maybe	13
279	IPt	section of Tensleep Sandstone	09S	28E	34			45.00828	-108.2809	TRS	NAD	32		Sandstone: porous, white, weathers gray	fine	slightly calcareous, porous			5	yes	13
280	IPt	section of Tensleep Sandstone	09S	28E	34			45.00828	-108.2809	TRS	NAD	32		Sandstone: friable, ledge forming, cross bedded, white to light gray, weathers brown	medium	calcareous at top, friable			5	yes	13
281	IPt	section of Tensleep Sandstone	09S	28E	34			45.00828	-108.2809	TRS	NAD	32		Sandstone: crossbedded and nodular in upper half, greenish gray, weathers light brown	medium	slightly calcareous			3	no	13
282	Mk	No. 1 of the Big Snowy Group, Belt Creek	17N	06E	1		sec. 1 and 11, T. 17 N., R. 6 E.	47.26378	-110.9065	TRS	NAD	114	16	Sandstone, siltstone and shale interbedded: reddish with some green beds, weathers platy to hackly		calcareous, slightly resistant			38	no	14

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283	Mk	No. 1 of the Big Snowy Group, Belt Creek	17N	06E	1			47.26378	-110.9065	TRS	NAD	114		Sandstone: some gypsum beds in basal portion, shaly and poorly exposed, reddish	fine	rather resistant			101	no	14
284	Mk	No. 1 of the Big Snowy Group, Belt Creek	17N	06E	11		sec. 1 and 11, T. 17 N., R. 6 E.	47.24879	-110.9277	TRS	NAD	114	16	Sandstone, siltstone and shale interbedded, reddish with some green beds, weathers platy to hackly		calcareous, slightly resistant			38	no	14
285	Mk	No. 1 of the Big Snowy Group, Belt Creek	17N	06E	11			47.24879	-110.9277	TRS	NAD	114		Sandstone: some gypsum beds basal portion shaly and poorly exposed, reddish	fine	rather resistant			101	no	14
286	Mk	No. 2 Delpine section	09N	10E	14		sec. 14, T. 9 N., R. 10 E.	46.54134	-110.4315	TRS	NAD	115	32	Sandstone, shale, limestone: interbedded, poorly exposed, partially cherty	fine-very fine	calcareous	sub-angular		23	no	14
287	Mk	No. 3 Judith River section	13N	11E	25	CB	NW 1/4, SW1/4, sec. 25, T. 13 N., R. 11 E.	46.8568	-110.2793	TRS	NAD	116	22	Sandstone: friable, pale lavender	very fine	calcareous, friable			9	no	14
288	Mk	No. 3 Judith River section	13N	11E	25	CB		46.8568	-110.2793	TRS	NAD	116	27	Sandstone: irregular bedding, shaly, punky, red with white blotches	very fine	shaly, slightly resistant	angular		7	no	14
289	Mk	No. 5 Potter Creek Dome section	13N	21E	5	C	SW1/4 sec. 5, T. 13 N., R.21 E.	46.91338	-109.0942	TRS	NAD	119	49	Sandstone: white to buff	fine	calcareous	subrounded		10	maybe	14
290	IPdp	No. 6 Durfee Creek Dome	12N	22E	24	A	NE1/4 sec. 24, T. 12 N., R. 22 E.	46.78995	-108.8879	TRS	NAD	119	4	Sandstone: porous, clean, beds about 8" thick, light gray to white	fine	calcareous, porous,	well rounded		7	yes	14
291	IPMt	No. 6 Durfee Creek Dome	12N	22E	24	A		46.78995	-108.8879	TRS	NAD	120	26	Sandstone: crossbedded, reddish brown	fine	calcareous, resistant	angular	poorly	24	no	14
292	IPMt	No. 6 Durfee Creek Dome	12N	22E	24	A		46.78995	-108.8879	TRS	NAD	120	28	Sandstone: crossbedded, sun cracked, quartz sand to clay, hematite and magnetite clasts up to 1/4" diameter. Basal portion (1ft) is more well rounded and well sorted, gray and light to dark brown,	fine to medium	quartz to clay		poorly	32	no	14
293	IPMt	No. 6 Durfee Creek Dome	12N	22E	24	A		46.78995	-108.8879	TRS	NAD	120	31	Sandstone: 1-2 ft beds, white to light gray	fine to medium	resistant bluff maker	well rounded	well	38	maybe	14
294	IPMt	No. 6 Durfee Creek Dome	12N	22E	24	A		46.78995	-108.8879	TRS	NAD	120		Sandstone: porous, rusty brown, grading downward to conglomerate, poorly stratified, slabby weathering,	coarse	porous	subrounded to angular chert, quartz and iron oxide fragments		15	maybe	14
295	Mk	No. 6 Durfee Creek Dome	12N	22E	24	A		46.78995	-108.8879	TRS	NAD	121	75	Sandstone and siltstone: thin bedded and some poorly exposed, gray to brown		some calcareous, some porous	subangular to rounded	well to poorly	16	maybe	14
296	Mk	No. 6 Durfee Creek Dome	12N	22E	24	A		46.78995	-108.8879	TRS	NAD	121	77	Sandstone: porous, light-brown to reddish-brown	fine to medium	calcareous, poorly , porous	angular	poorly	5	no	14
297	Mk	No. 6 Durfee Creek Dome	12N	22E	24	A		46.78995	-108.8879	TRS	NAD	121	79	Sandstone: silty, poorly bedded, light brown	fine	calcareous			1	no	14
298	Mk	No. 6 Durfee Creek Dome	12N	22E	24	A		46.78995	-108.8879	TRS	NAD	121	81	Sandstone: porous, poorly , 4" to 2' beds, red	medium	very calcareous, porous	subangular quartz to well rounded chert		11	maybe	14

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299	Mk	No. 6 Durfee Creek Dome	12N	22E	24	A		46.78995	-108.8879	TRS	NAD	121	87	Sandstone and sandy limestone: platy, ripple-marked, argillaceous, irregular thin beds, weathers readily, yellowish					12	no	14
300	IPdp	No. 7 State Road 25 and Stonehouse Canyon section	11N	21E	31	BN2	N1/2, NW1/4, sec. 31, T. 11 N., R. 21 E.	46.67512	-109.1322	TRS	NAD	122	4	Sandstone: porous, upper 6' friable, clean quartz sand, locally quartzitic to cherty, poorly bedded, white to mottled gray and pink	medium	non-calcareous, porous, upper 6' friable and nodular		well	18	yes	14
301	IPdp	No. 7 State Road 25 and Stonehouse Canyon section	11N	21E	31	BN2		46.67512	-109.1322	TRS	NAD	122	5	Sandstone, friable, siltstone and dolomite: interbedded, sandstone is white, gray, pink and purple.	fine to medium	mostly calcareous, friable, unresistant			35	no	14
302	IPMt	No. 7 State Road 25 and Stonehouse Canyon section	11N	21E	31	BN2		46.67512	-109.1322	TRS	NAD	123	33	Sandstone: mostly poorly exposed, upper part (6') mud cracked and ripple marked, lower part massive, crossbedded; white, gray, brownish	fine to medium	half calcareous, porous at bottom			21	maybe	14
303	Mk	No. 7 State Road 25 and Stonehouse Canyon section	11N	21E	31	BN2		46.67512	-109.1322	TRS	NAD	124	87	Sandstone: partly friable beds as thick as 3', gray to yellowish and brown	fine to medium	some calcareous in lower half, partly friable, porous			23	maybe	14
304	Mk	No. 7 State Road 25 and Stonehouse Canyon section	11N	21E	31	BN2		46.67512	-109.1322	TRS	NAD	124	89	Sandstone: impure quartz sand, yellow to gray with pink mottlings	fine to medium	calcareous		poorly	16	no	14
305	Mk	No. 7 State Road 25 and Stonehouse Canyon section	11N	21E	31	BN2		46.67512	-109.1322	TRS	NAD	124	91	Quartz sandstone: mottled pink and yellowish gray	medium	calcareous, porous		poorly	28	maybe	14
306	Mk	No. 7 State Road 25 and Stonehouse Canyon section	11N	21E	31	BN2		46.67512	-109.1322	TRS	NAD	124	93	Sandstone: impure quartz sand, greenish yellow and brown	medium	calcareous		poorly	3	no	14
307	Mk	No. 7 State Road 25 and Stonehouse Canyon section	11N	21E	31	BN2		46.67512	-109.1322	TRS	NAD	124	95	Sandstone: friable, yellow or mottled red, gray, and yellow,	very fine to medium grained	friable, porous, unresistant	some grains rounded and frosted		19	yes	14
308	Mk	No. 7 State Road 25 and Stonehouse Canyon section	11N	21E	31	BN2		46.67512	-109.1322	TRS	NAD	124	97	Sandstone: impure, grading into shaly siltstone, yellow, upper 3/4 grades upward from light brown to purple.	fine	calcareous			21	no	14
309	Mk	No. 7 State Road 25 and Stonehouse Canyon section	11N	21E	31	BN2		46.67512	-109.1322	TRS	NAD	124	99	Sandstone: light yellow to light brown, mostly with black spots that may be dried oil	fine	calcareous			12	maybe	14
310	IPMt	Of the type section of Big Snowy Group and reference section of Tyler Formation	13N	19E	25	CA	NE1/4, SW1/4, sec.,25, T. 13 N., R. 19 E.	46.85735	-109.2614	TRS	NAD83		13	Sandstone: cliff-maker, yellowish buff, red stained surface	very fine	calcareous			7	maybe	16

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311	IPMt	Of the type section of Big Snowy Group and reference section of Tyler Formation	13N	19E	25	CA		46.85735	-109.2614	TRS	NAD83		22	Sandstone: clean, porous 2" beds of alternating with shaly beds, light brown	fine	slightly resistant	sub angular		9	no	16
312	Mk	Of the type section of Big Snowy Group and reference section of Tyler Formation	13N	19E	25	CA		46.85735	-109.2614	TRS	NAD83		39	Sandstone: flaggy, poorly exposed, brown to reddish brown	fine	calcareous			30	maybe	16
313	Psh	Table 6. Stratigraphic section of the Shedhorn, Phosphoria, and Park City Formations	08S	02E	20	C	SW1/4 sec. 20, T. 8 S., R. 2 E.	45.11885	-111.5109	TRS	NAD	31		Sandstone: thick bedded; contains small chert nodules and thin streaks of very finely sandy to cherty carbonate rock, pale brown	fine	hard			12.8	no	17
314	Psh	Table 6. Stratigraphic section of the Shedhorn, Phosphoria, and Park City Formations	08S	02E	20	C		45.11885	-111.5109	TRS	NAD	31		Sandstone: massive, light brownish gray, contains nodules and columns of yellowish gray chert	fine to medium	hard			5.6	no	17
315	Psh	Table 6. Stratigraphic section of the Shedhorn, Phosphoria, and Park City Formations	08S	02E	20	C		45.11885	-111.5109	TRS	NAD	31		Sandstone: massive, contains lenses and flat pebbles of dense carbonate rock, silicified fossils, and many dark grains of phosphorite, light brownish gray	fine to coarse	hard			6.5	no	17
316	Psh	Table 6. Stratigraphic section of the Shedhorn, Phosphoria, and Park City Formations	08S	02E	20	C		45.11885	-111.5109	TRS	NAD	31		Sandstone: massive, contains dark phosphorite, solid hydrocarbon and columns of chert; pale brown	fine	hard			28.4	no	17
317	IPq	section A	06S	05W	21	BB		45.3035	-112.2284	TRS	NAD	134	20	Quartz sandstone: well , very pale orange	very fine grained	calcareous , well			12	no	18
318	IPq	section A	06S	05W	21	BB		45.3035	-112.2284	TRS	NAD	135	15	Quartz sandstone: moderate orange to pink, breccia of tectonic origin	fine	calcareous			5	no	18
319	Mk	section B	06S	05W	7	AAS2		45.33253	-112.2543	TRS	NAD	137	3	Quartz sandstone: thick bedded but finely laminated, pale reddish brown	fine to medium				0.5	maybe	18
320	Mk	section B	06S	05W	7	AAS2		45.33253	-112.2543	TRS	NAD	136	12	Quartz sandstone: medium bedded and contains pink chert grains; moderate orange - pink	medium				2	no	18
321	Mk	section B	06S	05W	7	AAS2		45.33253	-112.2543	TRS	NAD	136	13	Quartz sandstone: thick bedded, pale reddish brown	fine to medium				2.5	maybe	18
322	Mk	section B	06S	05W	7	AAS2		45.33253	-112.2543	TRS	NAD	136	15	Quartz sandstone: medium bedded and contains pink chert grains; moderate orange - pink					1	no	18
323	Mk	section B	06S	05W	7	AAS2		45.33253	-112.2543	TRS	NAD	136	17	Quartz sandstone: medium bedded, pale reddish brown	fine to medium				2	maybe	18
324	Mk	section B	06S	05W	7	AAS2		45.33253	-112.2543	TRS	NAD	136	20	Quartz sandstone: medium bedded, pale reddish brown					3	maybe	18
325	Mk	section B	06S	05W	7	AAS2		45.33253	-112.2543	TRS	NAD	136	21	Quartz sandstone: medium bedded and contains pink chert grains; moderate orange - pink					0.5	no	18
326	Mk	section B	06S	05W	7	AAS2		45.33253	-112.2543	TRS	NAD	136	23	Quartz sandstone: medium bedded and contains pink chert grains, moderate orange - pink					2.5	no	18

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327	Cf	section L	06S	05W	24	CD		45.29257	-112.1615	TRS	NAD	179	1	Quartz sandstone: with manganese and limonite staining; dusky yellow-brown to brownish black and dark yellowish orange	medium and coarse		subangular to subrounded quartz		0.5	no	18
328	Cf	section L	06S	05W	24	CD		45.29257	-112.1615	TRS	NAD	179	2	Quartz sandstone: conglomeratic with quartz clasts; dusky yellow-brown to brownish black and dark yellowish orange	pebbles and cobbles		subangular to subrounded		0.5	no	18
329	Cf	section L	06S	05W	24	CD		45.29257	-112.1615	TRS	NAD	179	3	Quartz sandstone: thick bedded, light brown,	very fine to fine		well		4.5	no	18
330	Cf	section L	06S	05W	24	CD		45.29257	-112.1615	TRS	NAD	179	4	Quartz sandstone: moderate orangish-pink, mottled moderate reddish-brown	fine with some quartz pebbles		subrounded to rounded		1	maybe	18
331	Cf	section L	06S	05W	24	CD		45.29257	-112.1615	TRS	NAD	179	5	Quartz sandstone: thick bedded, light brown					3.5	maybe	18
332	Cf	section L	06S	05W	24	CD		45.29257	-112.1615	TRS	NAD	179	6	Sandstone: thick bedded, limonite and hematite spots throughout, dark yellowish orange	fine		rounded		5	maybe	18
333	Cf	section L	06S	05W	24	CD		45.29257	-112.1615	TRS	NAD	178	8	Sandstone: medium and thick bedded, limonite and hematite spots throughout, dark yellowish orange					5.8	maybe	18
334	Cf	section L	06S	05W	24	CD		45.29257	-112.1615	TRS	NAD	178	9	Quartz sandstone: friable, upper 3" contains angular quartz clasts, medium bedded, very pale orange	fine	friable	subrounded		1	maybe	18
335	Cf	section L	06S	05W	24	CD		45.29257	-112.1615	TRS	NAD	178	10	Quartz sandstone: thick bedded, light brown	very fine				8	maybe	18
336	Cf	section L	06S	05W	24	CD		45.29257	-112.1615	TRS	NAD	178	12	Quartz sandstone: friable, medium bedded, light brown	fine	friable, slightly calcareous	subangular to subrounded		7	yes	18
337	Cf	section L	06S	05W	24	CD		45.29257	-112.1615	TRS	NAD	178	14	Quartz sandstone: medium bedded, light brown					1.5	maybe	18
338	Cf	section L	06S	05W	24	CD		45.29257	-112.1615	TRS	NAD	178	16	Quartz sandstone: light brown	fine	well			4	no	18
339	Cf	section L	06S	05W	24	CD		45.29257	-112.1615	TRS	NAD	178	17	Quartz sandstone: medium bedded, pinkish-gray	fine to medium		subrounded		3	maybe	18
340	Cf	Meagher(?)-Pilgrim - Wolsey-Flathead Formations	08S	02W	1		North side of Dry Hollow	45.16716	-111.7917	TRS	NAD	75	1	Quartzitic sandstone: thin bedded to massive, upper 15 ft makes ledge; grayish-orange to dark yellowish orange	medium to fine	locally calcareous			63	maybe	19
341	IPq	Quadrant Formation	10S	02W	36		Head of cirque on southeast face of Bighorn Mountain	44.91911	-111.791	TRS	NAD	80	2	Quartzose sandstone: some brecciation, rock slope, grayish orange to light gray and white		locally calcareous and quartzitic			44	no	19
342	IPq	Quadrant Formation	10S	02W	36			44.91911	-111.791	TRS	NAD	80	3	Quartzose sandstone: massive, cross bedded, cliff forming, grayish orange to white		quartzitic			75	maybe	19
343	IPq	Quadrant Formation	10S	02W	36			44.91911	-111.791	TRS	NAD	80	4	Quartzose sandstone: thin bedded, some brecciation near bottom, two beds (4") of dolomite at bottom, cliff forming, light gray to white	fine	quartzitic			40	no	19
344	IPq	Quadrant Formation	10S	02W	36			44.91911	-111.791	TRS	NAD	80	5	Quartzose sandstone: one bed, moderate red					6	maybe	19
345	IPq	Quadrant Formation	10S	02W	36			44.91911	-111.791	TRS	NAD	80	6	Sandstone: thin bedded, interbedded with dense dolomite, weathers into blocks, ledge forming, white	fine	quartzitic			16	maybe	19
346	IPq	Quadrant Formation	10S	02W	36			44.91911	-111.791	TRS	NAD	81	9	Quartzose sandstone: massive, some brecciation, white to grayish orange	fine	locally quartzitic			54	maybe	19
347	IPq	Quadrant Formation	10S	02W	36			44.91911	-111.791	TRS	NAD	81	10	Sandstone: one bed, ledge forming, dusky red	fine	quartzitic			3	maybe	19

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348	IPq	Quadrant Formation	10S	02W	36			44.91911	-111.791	TRS	NAD	81	11	Quartzose sandstone: thin bedded, moderate red	fine	non-resistant			2	maybe	19
349	IPq	Quadrant Formation	10S	02W	36			44.91911	-111.791	TRS	NAD	81	13	Quartzose sandstone: massive, some brecciation in basal part, some cross bedding, cliff forming, white to pale yellowish orange	fine	quartzitic			125	maybe	19
350	IPq	Quadrant Formation	10S	02W	36			44.91911	-111.791	TRS	NAD	81	14	Quartzose sandstone: medium bedded with some thin beds of dense dolomite, slope forming, white to pale yellowish orange, locally purplish	fine				30	no	19
351	IPq	Quadrant Formation	10S	02W	36			44.91911	-111.791	TRS	NAD	81	15	Quartzose sandstone: medium to thick bedded, alternates with dolomite at bottom, medium light gray to grayish orange, locally moderate red		locally quartzitic			64	no	19
352	IPt	section of the Tensleep Sandstone	06S	25E	7	D		45.32446	-108.6925	TRS	NAD	13		Sandstone: argillaceous, cream-colored to buff		slightly calcareous, easily eroded			21	no	20
353	IPt	section of the Tensleep Sandstone	06S	25E	7	D		45.32446	-108.6925	TRS	NAD	13		Sandstone: beds 2'-6' thick, resistant to erosion and weathering, buff	very coarse				84	no	20
354	Tr c	section of the Chugwater formation	06S	24E	36	C		45.26619	-108.7346	TRS	NAD	15		Sandstone: regular beds, , veined and interlaminated with gypsum, dark to bright red	coarse				55	no	20
355	Tr c	section of the Chugwater formation	06S	24E	36	C		45.26619	-108.7346	TRS	NAD	16		Sandstone: gypsiferous, thin bedded, wave ripples and cross beds, red brown		not resistant to erosion			17	no	20
356	Tr c	section of the Chugwater formation	06S	24E	36	C		45.26619	-108.7346	TRS	NAD	16		Sandstone: well laminated, contains a lot of red clay, gypsum veinlets, cross bedding, bright red					50	no	20
357	Tr c	section of the Chugwater formation	06S	24E	36	C		45.26619	-108.7346	TRS	NAD	16		Sandstone: argillaceous, gray to brown		non resistant			12	no	20
358	Tr c	section of the Chugwater formation	06S	24E	36	C		45.26619	-108.7346	TRS	NAD	16		Sandstone: well laminated and contains few gypsum laminae, brick red	very fine	more resistant than above			5	no	20
359	Tr c	section of the Chugwater formation	06S	24E	36	C		45.26619	-108.7346	TRS	NAD	16		Sandstone: brick red	fine				2	maybe	20
360	Tr c	section of the Chugwater formation	06S	24E	36	C		45.26619	-108.7346	TRS	NAD	16		Sandstone: rippled, dark brick red	fine				13	maybe	20
361	Cf	section of the Flathead Formation	09N	09E	13	BDA	0.55 miles S55?W of Flagstaff Reservoir Dam	46.54369	-110.5366	TRS	NAD	110	4	Sandstone: dominantly quartz, thin bedded, worm molds, hogback former, grayish red	medium	silica, well indurated	subrounded to sub angular	fair	55	no	21
362	Cf	section of the Flathead Formation	09N	09E	13	BDA		46.54369	-110.5366	TRS	NAD	110	2	Sandstone: dominantly quartz, thin-bedded, no worm molds as seen above, hogback former, grayish orange -pink, weathers light brown	coarse	silica, well indurated	subrounded	poor	28	no	21
363	IPMa	Table 7	09N	10E	31	BCC	0.28 miles N45?W of Coyote Springs no .697	46.4984	-110.5242	TRS	NAD	116	1	Sandstone: moderate feldspar, subordinate sublithic fragments, woody fragments, thin bedded, poorly exposed and subdued ridge former, pale yellow orange	fine	grades upwards from non calcareous to very calcareous	angular quartz	fair	140	no	21
364	IPq	Table 8	08N	09E	2	CBC	2.3 miles N28?W of Bonanza Ranch	46.48057	-110.5748	TRS	NAD	117	6	Sandstone: thick bedded, crude cross bedding near top, ledge former, light gray	medium	siliceous	dominantly angular quartz	fair	55	no	21

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365	IPq	Table 8	08N	09E	2	CBC	2.3 miles N28?W of Bonanza Ranch	46.48057	-110.5748	TRS	NAD	117	4	Sandstone: very thin bedded, limonite? staining, subdued ledge former, weathers light brown,		siliceous	subrounded quartz dominated		10	no	21
366	IPq	Table 8	08N	09E	2	CBC	2.3 miles N28?W of Bonanza Ranch	46.48057	-110.5748	TRS	NAD	117	3	Sandstone: cross-bedded, subdued ledge former, limonitic staining, yellow-gray, weathers dark yellow orange	fine				5	no	21
367	IPq	Table 8	08N	09E	2	CBC	2.3 miles N28?W of Bonanza Ranch	46.48057	-110.5748	TRS	NAD	117	1	Sandstone: dominantly quartz with very subordinate dark fragments, cross bedded, light gray,	medium	well indurated	rounded quartz	poorly	16	no	21
368	Ke	Table 12	08N	09E	26	BBD	1.3 miles NW of Old Lennep General Store	46.42979	-110.5721	TRS	NAD	124	30	Sandstone: dominantly quartz with trace of woody fragments, crossbedded major bluff former, light gray	medium	very calcareous	angular quartz		41.8	no	21
369	Ke	Table 12	08N	09E	26	BBD	1.3 miles NW of Old Lennep General Store	46.42979	-110.5721	TRS	NAD	124	28	Sandstone: cross laminated, moderate woody chips, sharp ridge former, medium light gray, weathers into square yellow gray chips	very fine	very calcareous			36.5	no	21
370	Ke	Table 12	08N	09E	26	CAB		46.42435	-110.5695	TRS	NAD	125	22	Sandstone: quartz, feldspar and moderate woody fragments, very thinly bedded, low ledge former, numerous pelecypod fragments, olive gray	very fine	very calcareous	angular quartz	poorly	1.2	no	21
371	Ke	Table 12	08N	09E	26	CAB		46.42435	-110.5695	TRS	NAD	125	21	Sandstone: subordinate feldspar, moderate woody fragments, low ridge former, thin bedded, yellow gray	very fine	very calcareous	angular quartz	poorly	7.8	no	21
372	Ke	Table 12	08N	09E	26	CAB		46.42435	-110.5695	TRS	NAD	125	19	Sandstone: subordinate feldspar, thick-cross-bedded, limestone concretions weathering out, subdued ridge former, light olive gray	very fine	very calcarous	angular quartz	good	3.3	no	21
373	Ke	Table 12	08N	09E	26	CAB		46.42435	-110.5695	TRS	NAD	126	17	Sandstone: dominantly angular quartz, moderate feldspar, numerous biotite flakes, cross laminated, numerous leaf impressions, subdued ridge former, light olive gray	very fine	ridge former			1	no	21
374	Ke	Table 12	08N	09E	26	CAB		46.42435	-110.5695	TRS	NAD	126	15	Sandstone: dominantly angular quartz, moderate feldspar, numerous biotite flakes, cross laminated, low sharp ridge former, light olive gray	very fine	very calcareous	angular quartz	good	1	no	21
375	Ke	Table 12	08N	09E	26	CAB		46.42435	-110.5695	TRS	NAD	126	13	Sandstone: abundant quartz and feldspar, thin beds, cross bedded, low rounded ridge former, light olive gray	very fine	carbonate	subrounded	fair	3.1	no	21
376	Ke	Table 12	08N	09E	26	CAB		46.42435	-110.5695	TRS	NAD	126	11	Sandstone: dominantly quartz, subordinate feldspar, trace biotite, strongly cross laminated, low ridge former, light olive gray	very fine	moderate carbonate	angular quartz	fair	2.3	no	21
377	Ke	Table 12	08N	09E	26	CAB		46.42435	-110.5695	TRS	NAD	126	9	Sandstone: dominantly quartz, moderate biotite, trace feldspar, thin cross-bedded	very fine	carbonate	subangular quartz to well rounded chert	fair	4	no	21
378	Ke	Table 12	08N	09E	26	BDD		46.42616	-110.5669	TRS	NAD	127	7	Sandstone: dominantly quartz, subordinate feldspar, numerous biotite flakes, thin cross bedded, low ridge former, light olive gray					4	no	21
379	Ke	Table 12	08N	09E	26	BDD		46.42616	-110.5669	TRS	NAD	127	5	Sandstone: dominantly quartz, subordinate feldspar, numerous biotite flakes, thin cross bedded, low ridge former, light olive gray					4.1	no	21
380	Ke	Table 12	08N	09E	26	BDD		46.42616	-110.5669	TRS	NAD	127	3	Sandstone: dominantly quartz, subordinate feldspar, numerous biotite flakes, thin cross bedded, low ridge former, light olive gray	very fine	abundant carbonate	angular quartz	fair	3.8	no	21
381	Ke	Table 12	08N	09E	26	BDD		46.42616	-110.5669	TRS	NAD	127	1	Sandstone: dominantly quartz, abundant biotite flakes, low sharp ridge former, yellow gray	very fine	much carbonate	subangular quartz	poorly	3	no	21
382	Psh	Shedhorn (?) Sandstone and equivalent strata on the SW flank of White Peak	11S	04E	2	B	SW flank of White Peak	44.90829	-111.2106	TRS	NAD	93		Sandstone: thin to medium bedded, contains much light gray chert, forms steep slope, dark brown to grayish brown	fine to medium				62	no	22

sectionId	Unit Symbol	Measured Section Name	TWP	Rng	Sec	Qsec	Loc Notes	Lat (Apprx)	Long (Apprx)	method	Horizontal Datum	Page Num	Sub Unit Id	Description	Grain Size	Cementation	Roundness	Sorting	Thick Ft	Suitability?	Ref Id
383	Psh	Shedhorn (?) Sandstone and equivalent strata on the SW flank of White Peak	11S	04E	2	B	SW flank of White Peak	44.90829	-111.2106	TRS	NAD	93		Sandstone: thin to medium bedded, even bedding, cross bedding, locally conglomaratic and contains much chert, light brown to grayish brown	very fine to coarse				22	no	22
384	Cf	3.Gordon Shale, Flathead Sandstone, and McNamara Formation	21N	11W	9		on west side of the upper reaches of Reef Creek about one mile south of Prairie Reef Lookout	47.5879	-113.0218	TRS	NAD83		32	Sandstone: cross-bedded, iron stained, organic trails and burrows, yellowish-gray	fine to medium	non calcareous			24	maybe	23
385	Cf	3.Gordon Shale, Flathead Sandstone, and McNamara Formation	21N	11W	9			47.5879	-113.0218	TRS	NAD83		31	Sandstone: iron stained, thin to thick bedded, vertical light gray veinlets in upper beds organic trails and burrows, yellowish-gray	medium to coarse			poorly	12.5	maybe	23
386	Cf	3.Gordon Shale, Flathead Sandstone, and McNamara Formation	21N	11W	9			47.5879	-113.0218	TRS	NAD83		30	Sandstone: iron stained, thin to thick bedded, vertical light gray veinlets in upper beds, organic trails and burrows, cross bedded, one thin gray shale bed, yellowish-gray	medium to coarse			poorly	7	maybe	23
387	Cf	3.Gordon Shale, Flathead Sandstone, and McNamara Formation	21N	11W	9			47.5879	-113.0218	TRS	NAD83		29	Sandstone: with shale and sandy shale, very finely micaceous, laminated, maroon					10	no	23
388	Cf	3.Gordon Shale, Flathead Sandstone, and McNamara Formation	21N	11W	9			47.5879	-113.0218	TRS	NAD83		28	Sandstone: massive, crossbedded, light yellowish gray					1	maybe	23
389	Cf	3.Gordon Shale, Flathead Sandstone, and McNamara Formation	21N	11W	9			47.5879	-113.0218	TRS	NAD83		27	Sandstone: with shale and sandy shale, very finely micaceous, laminated, maroon	very fine				4	no	23
390	Cf	3.Gordon Shale, Flathead Sandstone, and McNamara Formation	21N	11W	9			47.5879	-113.0218	TRS	NAD83		26	Sandstone: massive, crossbedded, light yellowish gray	fine to medium	poorly indurated			1.3	maybe	23
391	Cf	3.Gordon Shale, Flathead Sandstone, and McNamara Formation	21N	11W	9			47.5879	-113.0218	TRS	NAD83		25	Sandstone with shale and sandy shale, very finely micaceous, laminated, organic bioturbation, maroon	very fine				3.7	no	23
392	Cf	3.Gordon Shale, Flathead Sandstone, and McNamara Formation	21N	11W	9			47.5879	-113.0218	TRS	NAD83		24	Sandstone: massive, lower bed is mainly quartz pebble conglomerate, thinly laminated and cross bedded, some shale layers near bottom, thin bedded, mud cracks, bioturbation, yellowish-gray		poorly indurated		poorly	12.5	no	23
393	Cf	3.Gordon Shale, Flathead Sandstone, and McNamara Formation	21N	11W	9			47.5879	-113.0218	TRS	NAD83		23	Sandstone: massive, lower bed is mainly quartz pebble conglomerate, thinly laminated and cross bedded, some shale layers near bottom, yellowish-gray	coarse	poorly indurated		poorly	30	no	23
394	Kblf	18. Blackleaf, Kootenai, and Morrison Formations	23N	09W	34	B	Exposed on west side of upper reaches of Hannan Gulch	47.70811	-112.7503	TRS	NAD83		47	Sandstone: finely micaceous, mostly chert quartz and feldspar, thin bedded in upper part, faulted, forms prominent ridge, weathers yellowish gray and has red iron stains	very fine	noncalcareous			30	no	23
395	Kblf	18. Blackleaf, Kootenai, and Morrison Formations	23N	09W	34	B		47.70811	-112.7503	TRS	NAD83		46	Sandstone: mostly quartz with chert and feldspar, very thinly bedded, thin sandy shale beds, limestone concretion in lower part, weathers blocky, gray with greenish tint	very time	noncalcareous			29	no	23

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396	Kblf	18. Blackleaf, Kootenai, and Morrison Formations	23N	09W	34	B		47.70811	-112.7503	TRS	NAD83		44	Sandstone: with thin shale partings in upper and lower parts, cross bedded, clear quartz and some chert grains, very thinly bedded, weathers blocky, very light gray	very fine	noncalcareous, hard			12.6	no	23
397	Kblf	18. Blackleaf, Kootenai, and Morrison Formations	23N	09W	34	B		47.70811	-112.7503	TRS	NAD83		43	Sandstone: mainly quartz with feldspar and chert, crossbedded, many lentils of very coarse sandstone, many granules of claystone, ripple marked, and thin shale partings in lower part, gray with greenish tint	very fine	noncalcareous, hard			6.9	no	23
398	Kblf	19. Flood Shale Member of the Blackleaf Formation and the upper part of the Kootenai Formation					exposed in a gulch just SW of the east end of the Sheep Mountains						45	Sandstone (B bed): finely micaceous, thin bedded, heavily iron stained, conchoidal fracture, wood fragments, yellowish gray	fine				28	no	23
399	Kblf												42	Sandstone: with shale partings, very thin bedded, some cross bedding, heavily iron stained, weathers blocky, lower beds transitional to shale, gray, weathers yellowish gray					5	no	23
400	Kblf												38	Sandstone: with shale partings, gray, very thin bedded, some cross bedding, heavily iron stained, weathers blocky; gray, weathers yellowish gray	very fine				24	no	23
401	Kblf												35	Sandstone: weathers yellowish gray, one bed, weathers blocky, gray	very fine	slightly calcareous			0.6	maybe	23
402	Kblf												31	Sandstone (A bed): in beds up to 2.5' thick, heavily iron stained	fine				19	maybe	23
403	Kblf	20.Flood Shale Member of the Blackleaf Formation	22N	08W	31	AA	north side of irrigation canal in center NE 1/4, NE1/4, Teton County Check Mudge USGS PP 663-A	47.62375	-112.6729	TRS	NAD83		11	Sandstone: mainly clear quartz some chert grains, many shale partings in lower part, forms massive hillside bench with vertical cliff, light gray in upper part, dark gray in lower	fine-very fine				22.5	maybe	23
404	Kblf	20.Flood Shale Member of the Blackleaf Formation	22N	08W	31	AA		47.62375	-112.6729	TRS	NAD83		10	Sandstone: with many silty/shaly partings,lenticular and nodular beds, worm burrows, dark-gray	very fine	noncalcareous			18	no	23
405	Kblf	20.Flood Shale Member of the Blackleaf Formation	22N	08W	31	AA		47.62375	-112.6729	TRS	NAD83		7	Sandstone: weathers blocky, small organic burrows locally abundant, dark-gray, blue tint on broken surfaces	very fine	calcareous			0.6	no	23
406	Kblf	20.Flood Shale Member of the Blackleaf Formation	22N	08W	31	AA		47.62375	-112.6729	TRS	NAD83		3	Sandstone: massive, weathers brownish gray, upper part has platy weathering and wood fragments, lower part weathers blocky, dark gray	very fine	calcareous				no	23
407	Kblf	21. Flood Shale Member of the Blackleaf Formation	21N	09W	19		west side of saddle between Dry Fork and Stovepipe Creek, Patricks Basin Quadrangle	47.55915	-112.8084	TRS	NAD83		4	Sandstone: mostly quartz, with sandy shale interbeds, ripple marks and organic burrows, yellowish-gray	very fine				13.5	no	23
408	Kblf	21. Flood Shale Member of the Blackleaf Formation	21N	09W	19			47.55915	-112.8084	TRS	NAD83		1	Sandstone: mostly quartz, thinly laminated, asymmetrical ripple marks trending north, gray, weathers yellowish gray	fine to medium				6	maybe	23
409	Kv	37. Two Medicine Formation, Virgelle Formation and Telegraph Creek Formation	22N	08W	28	C,D	in the north stream bank of the Sun River	47.62666	-112.6412	TRS	NAD83		24	Sandstone: clear quartz and some chert, locally very micaceous, crossbedded, thin bedded, many sandstone concretions and nodules some heavily iron stained, rounded clay clasts in uppermost bed	fine	calcareous			149	maybe	23

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410	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	06N	01E	5	B		46.30786	-111.6355	TRS	NAD	51	72	Sandstone: weathered surface very rough, honey-colored,	very fine	dolomitic			2	maybe	24
411	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	06N	01E	5	B		46.30786	-111.6355	TRS	NAD	51	55	Sandstone: dolomitic		friable			1	maybe	24
412	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	06N	01E	5	B		46.30786	-111.6355	TRS	NAD	51	52	Sandstone: punky, almost white		calcareous			5.5	maybe	24
413	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	06N	01E	5	B		46.30786	-111.6355	TRS	NAD	51	49	Sandstone or sandy limestone: friable, light gray		calcareous, friable			10.5	maybe	24
414	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	06N	01E	5	B		46.30786	-111.6355	TRS	NAD	51	47	Sandstone: yellowish gray	fine	calcareous			2	maybe	24
415	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	06N	01E	5	B		46.30786	-111.6355	TRS	NAD	51	40	Sandstone: upper part quartzite, yellowish-gray and very light gray	fine	dolomitic			4	maybe	24
416	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	06N	01E	5	B		46.30786	-111.6355	TRS	NAD	51	35	Sandstone: thin bedded		dolomitic			2	maybe	24
417	IPMa	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	06N	01E	5	B		46.30786	-111.6355	TRS	NAD	51	29	Sandstone: gritty, cross bedded, pale red	coarse				1	no	24
418	IPMa	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	06N	01E	5	B		46.30786	-111.6355	TRS	NAD	51	28	Sandstone: very light gray	very fine	slightly dolomitic			0.5	maybe	24
419	IPMa	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	06N	01E	5	B		46.30786	-111.6355	TRS	NAD	51	27	Sandstone: oolitic, grayish red	very fine				1	no	24

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420	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	07N	01E	32			46.31896	-111.6304	TRS	NAD	51	72	Sandstone: weathered surface very rough, honey-colored	very fine	dolomitic			2	maybe	24
421	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	07N	01E	32			46.31896	-111.6304	TRS	NAD	51	55	Sandstone: friable, dolomitic		friable			1	maybe	24
422	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	07N	01E	32			46.31896	-111.6304	TRS	NAD	51	52	Sandstone: punky, almost white		calcareous			5.5	maybe	24
423	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	07N	01E	32			46.31896	-111.6304	TRS	NAD	51	49	Sandstone or sandy limestone: friable, light gray		calcareous, friable			10.5	maybe	24
424	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	07N	01E	32			46.31896	-111.6304	TRS	NAD	51	47	Sandstone: yellowish gray	fine	calcareous			2	maybe	24
425	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	07N	01E	32			46.31896	-111.6304	TRS	NAD	51	40	Sandstone: upper part quartzitic, yellowish-gray and very light gray	fine	dolomitic			4	maybe	24
426	IPq	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	07N	01E	32			46.31896	-111.6304	TRS	NAD	51	35	Sandstone: thin bedded, pale-yellowish-brown		dolomitic			2	maybe	24
427	IPMa	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	07N	01E	32			46.31896	-111.6304	TRS	NAD	51	29	Sandstone: gritty, cross bedded, pale red	coarse				1	no	24
428	IPMa	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	07N	01E	32			46.31896	-111.6304	TRS	NAD	51	28	Sandstone: very light gray	very fine	slightly dolomitic			0.5	maybe	24
429	IPMa	section 1. Morrison, Swift, Phosphoria, Quadrant, and Amsden Formations near Indian Creek	07N	01E	32			46.31896	-111.6304	TRS	NAD	51	27	Sandstone: oolitic, grayish red	very fine				1	no	24

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430	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	11	30	Sandstone: silty, thinly and irregularly bedded, some carbonaceous wisps, light yellowish gray, weathers light brownish orange	fine				10.4	no	25
431	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	12	29	Sandstone: quartz and chert ('salt and pepper'), massive, medium light gray, weathers yellow gray stained with limonite		matrix of sec.ondary calcite	quartz well to subrounded		1.1	no	25
432	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	12	28	Sandstone: concretionary, contains small amounts of ferruginous material, medium light gray, weathers yellowish brown to brown	fine	calcareous sec.ondary calcite			4.5	no	25
433	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	12	27	Sandstone: very friable, bedding indistinct, thickness varies, grayish yellow	fine	very friable			10	yes	25
434	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	12	26	Sandstone: quartz, some chert, cross bedded, mostly massive except 5 distinct parting planes, looks like near beach deposit, grayish yellow	medium			well	5.1	yes	25
435	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	12	25	Sandstone: friable, indistinctly bedded, grayish-yellow	fine	friable, slightly calcareous			6.2	yes	25
436	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	12	24	Sandstone: mostly quartz, massive, top film of clay, forms a prominent ledge overhanging beds below, grayish yellow, weathers grayish -orange yellow	fine to medium				12.6	maybe	25
437	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	12	23	Sandstone: fairly friable, indistinctly bedded, upper 36 cm weathers yellowish orange, light-yellowish gray		fairly friable and erodable			4.7	maybe	25
438	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	12	22	Sandstone: some flute casts and abundant casts of trace fossils, light olive gray	fine	hard to soft			2.3	maybe	25
439	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	12	21	Sandstone: silty, some finely macerated carbonaceous debris; nodular or chunky appearance, trace fossils on bedding surfaces, light gray	fine			poorly	3.2	no	25
440	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	12	20	Sandstone: silty, few rounded granules of dark chert, nodular or chunky, occasional discrete masses of concretionary marcasite, light gray	silty			poorly	4.6	no	25
441	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	12	12	Sandstone: upper surface ripple marked, ferruginous, lower part silty, contains small fragments of mineral charcoal and trace fossils, yellowish gray, weathers medium brown	medium				2	no	25
442	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	12	10	Sandstone: alternating sandstone and siltstone beds, sandstone crossbedded, slightly ferruginous, forms a ragged cliffy slope, light gray	fine - medium	more indurated			3.7	no	25
443	Kblf	Type section for Flood Member	20N	03E	7	ABC	4.5 miles west of Great Falls	47.50602	-111.3999	TRS	NAD	12	8	Quartzose sandstone: interbedded with about equal amounts of shaly siltstone with laminae marked by films of carbonaceous matter, trace of poorly preserved fossils, lentils of shaly siltstone, light olive gray					3.2	no	25
444	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	61	Sandstone: concretionary, concretions (large) are epigenetic and occupy scour channels in underlying sandstone, moderate gray	fine	calcareous			5.6	no	25
445	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	60	Sandstone: irregular wavy bedding, parted by laminae of medium gray shale, light yellowish gray	fine	calcareous			10.7	no	25
446	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	59	Sandstone: fine horizontal laminae, no cross lamination, grayish orange				poorly	0.5	maybe	25

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447	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	58	Sandstone: unweathered, caps excavated slope, grayish orange	fine	calcareous			4.3	maybe	25
448	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	57	Sandstone: cherty, tuffaceous, cross laminated, forms ledge, light yellowish gray	fine to coarse			poorly	1.4	no	25
449	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	56	Sandstone: unweathered, caps excavated slope, grayish orange	fine				2	maybe	25
450	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	55	Sandstone: massive, makes ledge with small overhang, light yellowish gray	medium	hard			1.2	no	25
451	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	54	Sandstone: irregular wavy layers with laminae of shale, light yellowish gray, weathers grayish orange	fine	calcareous			6.7	no	25
452	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	53	Sandstone: unweathered, irregular wavy layers with laminae of shale, caps excavated slope, light yellowish gray	fine	calcareous			8.5	no	25
453	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	52	Sandstone: contains irregular masses and partings of medium gray shale, olive gray	medium	soft		poorly	1.5	no	25
454	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	51	Sandstone: massive with trace fossils, light gray	fine	hard			0.3	no	25
455	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	50	Sandstone: thin parting of medium gray fissile shale, light gray	fine				3.3	no	25
456	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	48	Sandstone: traces of carbonaceous debris, small lenticular and nodular masses enclosed by sandy gray clay, indistinct bedding, ledge making, light gray	fine	faintly calcareous, resistant			5.5	no	25
457	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	46	Sandstone: massive, irregular inclusions of shale, olive		soft			2	no	25
458	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	45	Sandstone: with small amount of rounded polished black chert, flakes of carbonaceous material, small lenticular and nodular masses some enclosed by clay, very indistinct bedding, forms broken rubbly ledge, light yellowish gray	fine to medium	hard, faintly calcareous			1.9	no	25
459	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	41	Sandstone: with some rounded granules of gray chert, all in a matrix of light gray clay which also makes indistinct laminae, light olive gray, surface weathers dark yellowish orange	fine to coarse	non calcareous, soft, friable	subangular	poorly	0.4	no	25
460	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	13	39	Sandstone: thin slabby layers, olive gray	fine				0.9	maybe	25
461	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	14	37	Sandstone: finely laminated, presence of bioturbation, olive gray, weathers brown	fine				0.4	maybe	25
462	Kblf	Reference section for Flood Member	21N	03E	32	DCC		47.5253	-111.3761	TRS	NAD	14	34	Sandstone: massive, poorly stratified, organically reworked, burrows filled with clay shale, light olive gray, weathers light yellowish brown to dark yellowish orange	fine			poorly	2.4	no	25
463	Kblf	Reference section for Flood Member	20N	03E	5	AAB		47.52344	-111.3742	TRS	NAD	14	24	Sandstone: layers 9-15 cm thick parted by thin laminae of medium gray siltstone, trace fossils in upper part, light yellowish brown	fine				3.8	no	25
464	Kblf	Reference section for Flood Member	20N	03E	5	AAB		47.52344	-111.3742	TRS	NAD	14	22	Sandstone: interbedded with light olive sandy siltstone, upper surfaces show fossils, light yellowish gray	fine				1.2	no	25
465	Kblf	Reference section for Flood Member	20N	03E	5	AAB		47.52344	-111.3742	TRS	NAD	14	20	Sandstone: small flakes of carbonaceous debris, finely laminated layers separated by 6 mm thick laminae of light gray siltstone, makes subdued ledge with slightly undulating top, light yellowih gray	fine	faintly calcareous, hard, resistant			2.2	no	25
466	Kblf	Reference section for Flood Member	20N	03E	5	AAB		47.52344	-111.3742	TRS	NAD	14	19	Sandstone: interbedded with siltstone, bedding maked by thin laminae of clay, fragmented trace fossils, light yellowish gray	very fine				1.4	no	25
467	Kblf	Reference section for Flood Member	20N	03E	5	AAB		47.52344	-111.3742	TRS	NAD	14	18	Sandstone: silty, light olive	very fine				0.9	no	25

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468	Cf	section 4	02N	04W	14	AB	Black Butte, Jefferson County	45.93111	-112.0643	TRS	NAD	205		Sandstone: planar cross bedded, units are about 30 cm thick, pure white with limonite spots	medium	hard, well		moderately well	6.6	no	26
469	Cf	section 4	02N	04W	14	AB	Black Butte, Jefferson County	45.93111	-112.0643	TRS	NAD	205		Sandstone: limonitic, small scale cross bedding and planar laminations, light yellowish brown	medium	alternating poorly and well	subangular to subrounded	moderately well	23.1	maybe	26
470	Cf	section 4	02N	04W	14	AB	Black Butte, Jefferson County	45.93111	-112.0643	TRS	NAD	205		Sandstone: conglomerate at base, finer grained upwards, crossbedded, light brown		well consolidated			5	no	26
471	IPq	section 15	01N	03W	13	D,C	Jefferson Canyon, Madison County	45.83231	-111.9155	TRS	NAD	227		Quartz sandstone: thin bedded, white					5	maybe	26
472	IPq	section 15	01N	03W	13	D,C	Jefferson Canyon, Madison County	45.83231	-111.9155	TRS	NAD	227		Quartz sandstone: uniform, thinly laminated in part, medium bedded, massive, cliff forming, cross bedded at base, white					6.6	maybe	26
473	IPq	section 15	01N	03W	13	D,C	Jefferson Canyon, Madison County	45.83231	-111.9155	TRS	NAD	227		Quartz sandstone: uniform, thinly laminated in part, medium bedded and massive looking, cliff forming, brecciated at base, white	fine	moderately hard	subangular to subrounded	very well	23.1	maybe	26
474	Cf	section No. 5	02N	02W	31	E2	secondary road in Cottonwood Canyon	45.88189	-111.8967	TRS	NAD83		1	Orthoquartzite: thin bedded, white to brown, weathers red/brown	medium				4	no	27
475	Cf	section No. 5	02N	02W	31	E2	secondary road in Cottonwood Canyon	45.88189	-111.8967	TRS	NAD83		3	Orthoquartzite: thin bedded, white to brown, weathers red/brown	medium				2	no	27
476	Cf	section No. 5	02N	02W	31	E2	secondary road in Cottonwood Canyon	45.88189	-111.8967	TRS	NAD83		5	Sandstone: thin bedded, white and yellow	medium				10	maybe	27
477	Cf	section No. 5	02N	02W	31	E2	secondary road in Cottonwood Canyon	45.88189	-111.8967	TRS	NAD83		7	Orthoquartzite and sandstone: thin bedded, 3' above base is a 1' conglomerate bed containing well rounded quartz pebbles, alternating white and brown	medium				36	no	27
478	Cf	section No. 5	02N	02W	31	E2	secondary road in Cottonwood Canyon	45.88189	-111.8967	TRS	NAD83		9	Orthoquartzite: thin bedded, white to brown, weathers red/brown	medium				11	no	27
479	Cf	section No. 5	02N	02W	31	E2	secondary road in Cottonwood Canyon	45.88189	-111.8967	TRS	NAD83		11	Orthoquartzite: thin bedded, white to brown, weathers red/brown	medium				33	no	27
480	Cf	section No. 5	02N	02W	31	E2	secondary road in Cottonwood Canyon	45.88189	-111.8967	TRS	NAD83		13	Orthoquartzite: thin bedded, changes to sandstone near top of unit, white to brown, weathers red/brown	medium				36	no	27
481	Cf	section No. 5	02N	02W	32	W2	secondary road in Cottonwood Canyon	45.88187	-111.8763	TRS	NAD83		1	Orthoquartzite: thin bedded, white to brown, weathers red/brown	medium				4	no	27
482	Cf	section No. 5	02N	02W	32	W2	secondary road in Cottonwood Canyon	45.88187	-111.8763	TRS	NAD83		3	Orthoquartzite: thin bedded, white to brown, weathers red/brown	medium				2	no	27
483	Cf	section No. 5	02N	02W	32	W2	secondary road in Cottonwood Canyon	45.88187	-111.8763	TRS	NAD83		5	Sandstone: thin bedded, white and yellow	medium				10	no	27
484	Cf	section No. 5	02N	02W	32	W2	secondary road in Cottonwood Canyon	45.88187	-111.8763	TRS	NAD83		7	Orthoquartzite and sandstone: thin bedded, 3' above base is a 1' conglomerate bed containing well rounded quartz pebbles, alternating white and brown	medium				36	maybe	27
485	Cf	section No. 5	02N	02W	32	W2	secondary road in Cottonwood Canyon	45.88187	-111.8763	TRS	NAD83		9	Orthoquartzite: thin bedded, white to brown, weathers red/brown	medium				11	no	27
486	Cf	section No. 5	02N	02W	32	W2	secondary road in Cottonwood Canyon	45.88187	-111.8763	TRS	NAD83		11	Orthoquartzite: thin bedded, white to brown, weathers red/brown	medium				33	no	27
487	Cf	section No. 5	02N	02W	32	W2	secondary road in Cottonwood Canyon	45.88187	-111.8763	TRS	NAD83		13	Orthoquartzite: changes to sandstone near top of unit, thin bedded, white to brown, weathers red/brown	medium				36	no	27
488	IPMa	section of the Amsden Formation	05N	12W	34	ACB	E. Limb of Barker Creek Anticline	46.1461	-113.0876	TRS	NAD	13		Sandstone: friable, massive, light gray and brown	medium	friable			10.5	yes	28
489	IPMa	section of the Amsden Formation	05N	12W	34	ACB	E. Limb of Barker Creek Anticline	46.1461	-113.0876	TRS	NAD	13		Sandstone: thin to medium bedded, buff, weathers brown	fine	calcareous			29.1	maybe	28

sectionId	Unit Symbol	Measured Section Name	TWP	Rng	Sec	Qsec	Loc Notes	Lat (Apprx)	Long (Apprx)	method	Horizontl Datum	Page Num	Sub Unit Id	Description	Grain Size	Cementation	Roundness	Sorting	Thick Ft	Suit-ability?	Ref Id
490	Cf	Flathead section	01S	06E	10	AC	Along one of the forks of Middle Cottonwood Creek	45.76727	-110.9672	TRS	NAD	24	8	Sandstone: composed of quartz and green sand grains, in beds 1-2 ft thick,with specks and bands of iron oxide, fucoidal markings on the surface, white		silica			13	no	29
491	Cf	Flathead section	01S	06E	10	AC	Along one of the forks of Middle Cottonwood Creek	45.76727	-110.9672	TRS	NAD	24	7	Sandstone: speckled and banded with brown sandstone due to concentration of iron oxide, otherwise white					22	no	29
492	Cf	Flathead section	01S	06E	10	AC	Along one of the forks of Middle Cottonwood Creek	45.76727	-110.9672	TRS	NAD	26	6	Sandstone: shaly, green and brown					1	no	29
493	Cf	Flathead section	01S	06E	10	AC	Along one of the forks of Middle Cottonwood Creek	45.76727	-110.9672	TRS	NAD	26	4	Sandstone: green sand and brown iron oxide; white, mottled green brown and red brown					3	no	29
494	Cf	Flathead section	01S	06E	10	AC	Along one of the forks of Middle Cottonwood Creek	45.76727	-110.9672	TRS	NAD	26	2	Sandstone: some horizons quartzitic, local crossbedding, white, speckled with brown and red					35	no	29
495	IPq	Quadrant section	01N	06E	36	C	E. side of the Bridger Range	45.79051	-110.9286	TRS	NAD	61	2	Sandstone: quartzitic in places, massive, white	fine to medium	very resistant			67	no	29
496	IPq	Quadrant section	01N	06E	36	C	E. side of the Bridger Range	45.79051	-110.9286	TRS	NAD	61	1	Sandstone: some horizons quartzitic, local crossbedding, white, speckled with brown and red; has a brownish red color near bottom, some interbedded gray red sandy limestones near base	fine to medium	resistant			48	no	29
497	IPMa	South Angler	02N	06E	15			45.92333	-110.967	TRS	NAD83		18	Sandstone: thick purple siltstone layer in the middle part, brick rec					47	no	30
498	IPMa	South Angler	02N	06E	15			45.92333	-110.967	TRS	NAD83		20	Sandstone: pink					4	maybe	30
499	IPMa	South Angler	02N	06E	15			45.92333	-110.967	TRS	NAD83		22	Sandstone: pink	coarse	calcareous			4	maybe	30
500	IPMa	Southeast Sacajawea	02N	06E	26		One mile south of Fairy Lake	45.89439	-110.9461	TRS	NAD83		2	Sandstone: medium irregularly bedded, limonite stain and chert nodules, light yellow gray to yellow brown	medium	non-calcareous			8	no	30
501	IPMa	Southeast Sacajawea	02N	06E	26		One mile south of Fairy Lake	45.89439	-110.9461	TRS	NAD83		4	Quartz sandstone: thick irregular bedding, light yellow brown to pale brown (units 1-4 in this section could belong to Quadrant)	medium		subrounded to well rounded		21	yes	30
502	IPMa	Southeast Sacajawea	02N	06E	26		One mile south of Fairy Lake	45.89439	-110.9461	TRS	NAD83		6	Sandstone: calcareous sandstone, thick irregularly bedded, massive, pale yellow gray	medium	calcareous	subrounded to well rounded quartz		7	maybe	30
503	IPMa	Southeast Sacajawea	02N	06E	26		One mile south of Fairy Lake	45.89439	-110.9461	TRS	NAD83		8	Sandstone: thick irregular bedding, yellow brown	fine to medium	calcareous	subrounded quartz		7	maybe	30
504	IPMa	Southeast Sacajawea	02N	06E	26		One mile south of Fairy Lake	45.89439	-110.9461	TRS	NAD83		31	Sandstone: thick irregularly bedded, moderate brownish red to pale yellowish orange	fine	well indurated			14	no	30
505	IPMa	Southeast Sacajawea	02N	06E	26		One mile south of Fairy Lake	45.89439	-110.9461	TRS	NAD83		33	Sandstone: thick irregularly bedded, mottled in upper part, pale yellowish orange to grayish orange	fine to medium		subrounded quarts grains		40	maybe	30
506	IPMa	Southeast Sacajawea	02N	06E	26		One mile south of Fairy Lake	45.89439	-110.9461	TRS	NAD83		43	Sandstone: medium irregularly bedded, some clay pellet breccia, pale red to pale brownish red	fine to medium		subrounded quartz grains		10	no	30
507	IPMa	Ross Peak	01N	06E	2		East side of Ross Peak	45.86591	-110.9437	TRS	NAD83		17	Sandstone: massive, dark grayish red	fine	very well indurated			6	no	30
508	IPMa	Ross Peak	01N	06E	2		East side of Ross Peak	45.86591	-110.9437	TRS	NAD83		18	Sandstone and calcarenite: some interbedded red silt layers, pale yellowish orange	fine		subangular quartz		72	no	30
509	IPMa	Ross Peak	01N	06E	2		East side of Ross Peak	45.86591	-110.9437	TRS	NAD83		20	Sandstone: massive bedded, mottled grayish red, gray and white	very fine	well indurated			4.5	no	30
510	IPMa	Ross Peak	01N	06E	2		East side of Ross Peak	45.86591	-110.9437	TRS	NAD83		22	Sandstone: massive, dark grayish red	very fine	well indurated, resistant			3	no	30

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511	Jsw	Bighorn Lake	02N	06E	15		on ridge just south of Bighorn Lake	45.92333	-110.967	TRS	NAD83		1	Sandstone: thin to medium bedded, cross bedded, conglomerate in lower 8', fossiliferous, glauconitic, yellow gray to pale gray to pale orange	fine to coarse	calcareous			72	maybe	30
512	Jsw	Southeast Sacajawea	02N	06E	26		one mile south-southeast of Fairy Lake	45.89439	-110.9461	TRS	NAD83		1	Sandstone: 'salt and pepper', thin bedded, glauconitic, limonite stained, some fossils, yellow brown to gray brown	medium	resistant	subrounded quartz and chert		70	no	30
513	Jsw	Southeast Sacajawea	02N	06E	26		one mile south-southeast of Fairy Lake	45.89439	-110.9461	TRS	NAD83		2	Sandstone: 'salt and pepper', medium bedded, porous, glauconitic, limonite stained, some fossils, yellow brown to gray brown	medium	resistant	subrounded quartz and chert		10	no	30
514	Kk	Porcupine Ridge	07S	04E	21	DB	Gallatin County	45.20843	-111.2379	TRS	NAD83		29	Sandstone: hematite rich rims up to 1/4 inch thick, thin to thick bedded, splits slabby to blocky, forms cliffs and ledgy slopes, very light gray	fine	clean, siliceous		well	54	maybe	31
515	Kk	Porcupine Ridge	07S	04E	21	DB	Gallatin County	45.20843	-111.2379	TRS	NAD83		27	Sandstone: thin to medium bedded, forms an irregular cliff, several hematite rinds, pale red, weathers grayish red and pale reddish brown					12.2	maybe	31
516	Kk	Porcupine Ridge	07S	04E	21	DB	Gallatin County	45.20843	-111.2379	TRS	NAD83		25	Sandstone: medium to thick bedded, forms ledgy slopes, splits slabby to blocky, pale grayish red with brown specks, weathers grayish pink	fine				5.4	no	31
517	Kk	Porcupine Ridge	07S	04E	21	DB	Gallatin County	45.20843	-111.2379	TRS	NAD83		24	Sandstone: thick bedded, splits blocky, forms nearly vertical cliff, weathers to rubble, light grayish brown with brown and black specks, weathers a very pale orange					5	no	31
518	Kk	Porcupine Ridge	07S	04E	21	DB	Gallatin County	45.20843	-111.2379	TRS	NAD83		22	Sandstone: contains a few shaly lenses, thin bedded, splits flaggy to slabby, forms ledgy slopes, light brown to light gray at top, weathers with some iron staining	fine				17.6	no	31
519	Kk	Porcupine Ridge	07S	04E	21	DB	Gallatin County	45.20843	-111.2379	TRS	NAD83		20	Sandstone: forms ledgy slopes, massive, light gray, in places reddish brown	fine			well	10.4	no	31
520	Kk	Porcupine Ridge	07S	04E	21	DB	Gallatin County	45.20843	-111.2379	TRS	NAD83		6	Sandstone: thin to medium bedded, forms ledgy slopes, light grayish brown, stained reddish brown,	very fine	siliceous			6	no	31
521	Kk	Porcupine Ridge	07S	04E	21	DB	Gallatin County	45.20843	-111.2379	TRS	NAD83		5	Sandstone: clean, medium bedded forms ledges, white to very light gray	very fine	slightly calcareous			8.5	no	31
522	Kk	Porcupine Ridge	07S	04E	21	DB	Gallatin County	45.20843	-111.2379	TRS	NAD83		3	Sandstone: thin to medium bedded, splits flaggy to blocky, cross bedded, pinkish gray, weathers to moderate reddish orange	coarse to very coarse				15.3	no	31
523	Kk	Challenge Creek	29N	13W	32		1.5 miles upstream from Challenge Cabin	48.23047	-113.3252	TRS	NAD	179		Sandstone: argillaceous, indistinct bedding, gray green	very fine				10	no	32
524	Kk	Challenge Creek	29N	13W	32		1.5 miles upstream from Challenge Cabin	48.23047	-113.3252	TRS	NAD	179		Sandstone: argillaceous, indistinct bedding, gray green	fine				8	no	32
525	Kk	Challenge Creek	29N	13W	32		1.5 miles upstream from Challenge Cabin	48.23047	-113.3252	TRS	NAD	179		Sandstone: massive, some beds finely laminated, many fractures and slickenslides, carbon films on some laminae	fine	calcareous			96	no	32
526	Kk	Challenge Creek	29N	13W	32		1.5 miles upstream from Challenge Cabin	48.23047	-113.3252	TRS	NAD	179		Sandstone: massive, argillaceous, green	fine				5	no	32
527	Kk	Challenge Creek	29N	13W	32		1.5 miles upstream from Challenge Cabin	48.23047	-113.3252	TRS	NAD	180		Sandstone: argillaceous and micaceous, silty, medium bedded with thin shaly interbeds, green	fine				11	no	32
528	Kk	Challenge Creek	29N	13W	32		1.5 miles upstream from Challenge Cabin	48.23047	-113.3252	TRS	NAD	180		Sandstone: silty and micaceous, very thick bedded, green gray	fine				14	no	32

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529	Kk	Challenge Creek	29N	13W	32		1.5 miles upstream from Challenge Cabin	48.23047	-113.3252	TRS	NAD	180		Sandstone: carbonaceous, silty, thick to very thick bedding with thin shaly interbeds, gray-green	fine, several beds medium to coarse				85	no	32
530	Kk	Challenge Creek	29N	13W	32		1.5 miles upstream from Challenge Cabin	48.23047	-113.3252	TRS	NAD	180		Sandstone: contains numerous black chert grains, massive, blocky, gray-green	medium				47	no	32
531	Kk	Challenge Creek	29N	13W	32		1.5 miles upstream from Challenge Cabin	48.23047	-113.3252	TRS	NAD	180		Sandstone: silty with several cross laminated beds, concentrated calcite in concretionary zones, thick bedded, yellow-green	fine	calcareous			20	no	32
532	Kk	Challenge Creek	29N	13W	32		1.5 miles upstream from Challenge Cabin	48.23047	-113.3252	TRS	NAD	180		Sandstone: silty and argillaceous, flaggy (2-5 cm thick), yellow green	medium				45	no	32
533	Cf	Flathead Quartzite	04S	10E	23		Composite of Black Mountain area	45.47472	-110.4556	TRS	NAD83			Sandstone: local orthoquartzite, black iron oxide grains and layers, pinkish gray, pale red to blackish red, grayish purple, olive and black shale layers common near the top orthoquartzites gray to light brown	medium to very coarse	quartz contains limonite or hematite	Subrounded to well rounded	poorly	300	maybe	33
534	IPq	Quadrant Quartzite	11N	06W	30		Along the power line in this section	46.67768	-112.4006	TRS	NAD83			Orthoquartzite: with lenticular light gray to black chert layers. 5-10% porosity, white to gray	very fine to fine	compressed and well with quartz	subrounded	poorly	20	no	33
535	IPq	Quadrant Quartzite	11N	06W	30		Along the power line in this section	46.67768	-112.4006	TRS	NAD83			Sandstone: orthoquartzite where yellow and reddish hues are present, some worm borings which are poorly and porous, bottom is silty and somewhat calcareous, light gray to gray	silt to coarse, mostly fine	pressed and well with quartz	rounded to well rounded	fair to well	150	no	33
536	IPq	Quadrant Quartzite	10N	06W	20		Lower 125 ft of last section in this area	46.60552	-112.3796	TRS	NAD83			Quartzite: slightly calcareous, somewhat porous, poorly bedded, beds 2.5 - 5 cm thick, yellowish gray to grayish yellow green	fine	slightly calcareous			125	maybe	33
537	Kblf	Colorado Group Blackleaf Formation Flood Member Lower Quartzite Bed	11N	07W	36			46.66336	-112.4216	TRS	NAD83			Quartzite: locally has as much as 75% fine silt matrix, cross bedded and ripple-marked, colorless, white, very light gray to dark gray, bluish gray, and moderate brown	fine to medium grained				70	no	33
538	Kkg	Cloverly Formation (21) [Kootenai]	07S	24E	29		4.5 miles west of Bowler, Carbon County	45.19787	-108.8114	TRS	NAD83		3	Quartz arenite: cross bedded generally to the west, light yellowish brown to yellowish gray, weathering yellowish brown	medium grained	calcareous			61	yes	34
539	Kkg	Cloverly Formation (21) [Kootenai]	07S	24E	29		4.5 miles west of Bowler, Carbon County	45.19787	-108.8114	TRS	NAD83		1	Quartz arenite: cross bedded, basal part (1') is a green clay gall conglomerate, light yellowish brown to yellowish gray, weathers yellowish brown,	medium	calcareous			10	maybe	34
540	MDtr	2. section of Cambrian Hasmark Dolomite, Cambrian Red Lion Formation and Devonian Maywood Formation.	08N	13W	14	CC	NE side of Boulder Creek between Maxville and Princeton	46.44146	-113.2002	TRS	NAD	163	3	Quartz sandstone: dolomitic, beds 1/4' to 1' thick, finer toward the bottom of the unit, red to tan	fine	calcareous, fairly prominent outcrop	sub-angular to rounded quartz	fairly well	53	maybe	36
541	MDtr	2. section of Cambrian Hasmark Dolomite, Cambrian Red Lion Formation and Devonian Maywood Formation.	08N	13W	15	D	NE side of Boulder Creek between Maxville and Princeton	46.44306	-113.2078	TRS	NAD	163	3	Quartz sandstone: dolomitic, beds 1/4' to 1' thick, finer toward the bottom of the unit, red to tan	fine	calcareous, fairly prominent outcrop	sub-angular to rounded quartz	fairly well	53	maybe	36

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542	MDtr	2. section of Cambrian Hasmark Dolomite, Cambrian Red Lion Formation and Devonian Maywood Formation.	08N	13W	14	CC	NE side of Boulder Creek between Maxville and Princeton	46.44146	-113.2002	TRS	NAD	164	1	Quartz sandstone: with very minor amounts of finely crystalline sandy dolomite, beds 1"-8", medium gray, medium to dark gray weathering	fine	calcareous (20%)		not too well	7	maybe	36
543	MDtr	2. section of Cambrian Hasmark Dolomite, Cambrian Red Lion Formation and Devonian Maywood Formation.	08N	13W	15	D	NE side of Boulder Creek between Maxville and Princeton	46.44306	-113.2078	TRS	NAD	164	1	Quartz sandstone: with very minor amounts of finely crystalline sandy dolomite, beds 1"-8", medium gray, medium to dark gray weathering	fine	calcareous (20%)		not too well	7	maybe	36
544	IPq	4. section of the Quadrant Quartzite, Permian rocks and Jurassic rocks.	08N	12W	7	C,N	Fault-repetition of the west flank of the Douglas Mountain anticline on the North side of Gird Creek	46.45851	-113.1557	TRS	NAD	173	1	Orthoquartzite: assive, outcrop blocky and very prominent, white to light gray, buff to brown weatehring	fine	non calcareous (96% quartz)		poorly	120	no	36
545	IPMa	Table 3. Amsden section	02S	09W	7	B	North side of Canyon Creek	45.68192	-112.7687	TRS	NAD	37		Sandstone: massive beds, shaly greenish to maroon		calcareous			19.1	probabl	37
546	IPMa	Table 3. Amsden section	02S	09W	7	B	North side of Canyon Creek	45.68192	-112.7687	TRS	NAD	37		Sandstone: thin bedded, reddish brown to maroon		calcareous			36.9	probabl	37
547	IPMa	Table 3. Amsden section	02S	09W	7	B	North side of Canyon Creek	45.68192	-112.7687	TRS	NAD	37		Sandstone: thin bedded (2-3 inch) grading upward to argillaceous limestone		calcareous			21.3	no	37
548	IPMa	Table 3. Amsden section	02S	09W	7	B	North side of Canyon Creek	45.68192	-112.7687	TRS	NAD	37		Sandstone: thin bedded (1-3")	fine grained/ coarse sandstone					maybe	37
549	Mo [	section 4: Partial measured section Otter Formation	17N	04E	25	DC	1/4 mile above Calvert, Montana	47.19092	-111.1633	TRS	NAD	140	15	Sandstone: very friable, massive, minor planar crossbeds, light gray	fine grained	calcareous, VERY friable, crubles in hand.	well rounded	well	16	YES	38
550	Mo [	section 4: Partial measured section Otter Formation	17N	04E	25	DC	1/4 mile above Calvert, Montana	47.19092	-111.1633	TRS	NAD	140	3	Sandstone: friable, contains thin discontinuous carbonaceous partings, tan	fine	calcareous, friable			0.8	no	38
551	Kblf	section 8: Measured section of Flood Member of Blackleaf Formation and upper portion of the Kootenai Formation	19N	03E	17	BD	South side of Wilson Butte	47.40044	-111.383	TRS	NAD	148	37	Sandstone: massive toward base, irregular thin 4" beds to top contains quartz, plagioclase and minor chert, light tan		slighty calcareous			52.5	maybe	38
552	Kblf	section 8: Measured section of Flood Member of Blackleaf Formation and upper portion of the Kootenai Formation	19N	03E	17	BD	South side of Wilson Butte	47.40044	-111.383	TRS	NAD	148	35	Quartz sandstone: with minor amounts of plagioclase and chert, thin bedded (2-3"), small asymetrical ripplemarks, worm trails ubiquitous on bedding planes, tan to gray	fine to medium grained	slightly calcareous			20	maybe	38

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553	IPq	Sheep Creek	09S	08W	18	BBB	At the base of large Quadrant cliff on the northwest side of Sheep Creek Canyon	45.05706	-112.6397	TRS	NAD	138	37	Quartz arenite, cliff former, thickly bedded, some heavy mineral layers in laminae, very pale orange	fine	calcite, well indurated			170	no	39
554	IPq	Sheep Creek	09S	08W	18	BBB		45.05706	-112.6397	TRS	NAD	138	36	Quartz arenite: series of 2-5' ledge formers, medium bedded with isolated planar cross beds, white and locally hematite stained	fine	calcite			44	maybe	39
555	IPq	Sheep Creek	09S	08W	18	BBB		45.05706	-112.6397	TRS	NAD	138	34	Quartz arenite: 2-4' ledge formers, porous, medium bedded to massive, white, locally hematite stained	fine	calcite, porous			62	maybe	39
556	IPq	Sheep Creek	09S	08W	18	BBB		45.05706	-112.6397	TRS	NAD	138	32	Quartz arenite: porous, massive, 3-6' ledge formers, white with hematite stains	fine	calcite, porous			57	maybe	39
557	IPq	Sheep Creek	09S	08W	18	BBB		45.05706	-112.6397	TRS	NAD	138	31	Quartz arenite: subdued ledge former, thick to thin bedded, pale yellowish orange		calcite			17	maybe	39
558	IPq	Sheep Creek	09S	08W	18	BBB		45.05706	-112.6397	TRS	NAD	138	29	Quartz arenite: porous, subdued ledge former, medium bedded, very light gray	fine	calcite, porous			12	maybe	39
559	IPq	Sheep Creek	09S	08W	18	BBB		45.05706	-112.6397	TRS	NAD	139	28	Quartz arenite: ledge former, thin to medium bedded, pale yellowish orange	fine	calcite			5	maybe	39
560	IPq	Sheep Creek	09S	08W	18	BBB		45.05706	-112.6397	TRS	NAD	139	26	Quartz arenite: porous, ledge former, white, medium bedded	fine	silica, porous			12	maybe	39
561	IPq	Sheep Creek	09S	08W	18	BBB		45.05706	-112.6397	TRS	NAD	139	25	Quartz arenite: ledge former, medium bedded, very pale orange	fine	calcite			3	maybe	39
562	IPq	Sheep Creek	09S	08W	18	BBB		45.05706	-112.6397	TRS	NAD	139	24	Quartz arenite: ledge former, white, medium bedded, locally hematite stained	fine	silica			12	maybe	39
563	IPMs	Conover Ranch Formation	09S	08W	18	BBB		45.05706	-112.6397	TRS	NAD	139	22	Quartz arenite: ledge former, very pale orange	fine	calcite			1	maybe	39
564	IPMs	Conover Ranch Formation	09S	08W	18	BBB		45.05706	-112.6397	TRS	NAD	139	20	Quartz arenite: ledge former, thinly bedded with basal contact containing limestone rip up clasts from subadjacent unit, very pale orange		calcite			1	maybe	39
565	IPMs	Conover Ranch Formation	09S	08W	18	BBB		45.05706	-112.6397	TRS	NAD	140	14	Quartz arenite : ledge former, light brown	fine	calcite			3	maybe	39
566	IPMs	Conover Ranch Formation	09S	08W	18	BBB		45.05706	-112.6397	TRS	NAD	141	2	Quartz arenite : subdued ledge former, thinly bedded with localized planar cross bed sets, interbedded with grainstone lenses, yellowish gray		calcite			5	maybe	39
567	IPq	Ruby Gap	09S	03W	18	ACD	At the base of large, overturned Quadrant cliff located on the north side of the Upper Ruby River Road	45.05229	-112.0104	TRS	NAD	143	14	Quartzite: thickly bedded, cliff former, pale yellowish brown, locally iron stained	fine	well indurated			76	no	39
568	IPq	Ruby Gap	09S	03W	18	ACD		45.05229	-112.0104	TRS	NAD	143	13	Quartz arenite: massive, ledge former, yellowish gray	fine	calcite			16	maybe	39
569	IPq	Ruby Gap	09S	03W	18	ACD		45.05229	-112.0104	TRS	NAD	143	12	Quartzite: ledge former, heavily fractured, some surfaces display slickenslides, very pale orange					6	no	39
570	IPq	Ruby Gap	09S	03W	18	ACD		45.05229	-112.0104	TRS	NAD	143	11	Quartz arenite: ledge former, locally bioturbated, crude medium bedding with sporadic brown chert pods and stringers, yellowish gray	fine	dolomite			7	maybe	39
571	IPq	Ruby Gap	09S	03W	18	ACD		45.05229	-112.0104	TRS	NAD	143	10	Quartz arenite: massive, ledge former, pale yellowish brown		silica			6	maybe	39
572	IPq	Ruby Gap	09S	03W	18	ACD		45.05229	-112.0104	TRS	NAD	143	9	Quartz arenite: subdued ledge former, yellowish gray	fine	dolomite			3	maybe	39
573	IPq	Ruby Gap	09S	03W	18	ACD		45.05229	-112.0104	TRS	NAD	143	8	Quartz arenite: ledge former, massive, heavily fractured, yellowish gray		silica			9	maybe	39
574	IPq	Ruby Gap	09S	03W	18	ACD		45.05229	-112.0104	TRS	NAD	144	4	Quartz arenite: series of ledge formers, relict planar cross beds, heavily fractured, yellowish gray	fine	silica			35	maybe	39
575	IPq	Ruby Gap	09S	03W	18	ACD		45.05229	-112.0104	TRS	NAD	144	2	Quartz arenite: subdued ledge former, heavily fractured, light gray to yellowish gray	fine	calcite			13	maybe	39

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576	IPq	Snowcrest Mountain	10S	03W	6	ACC	on a prominent ridge just to the south of the southern fork of Romy Creek.	44.99382	-112.0145	TRS	NAD	146	25	Quartz arenite: ledge former, yellowish gray, locally surfaces mottled by iron stained dots	fine	dolomite			13	maybe	39
577	IPq	Snowcrest Mountain	10S	03W	6	ACC		44.99382	-112.0145	TRS	NAD	146	24	Quartz arenite: massive, ledge former, very pale orange	fine	calcite, very well indurated			14	no	39
578	IPq	Snowcrest Mountain	10S	03W	6	ACC		44.99382	-112.0145	TRS	NAD	146	23	Quartz arenite: ledge former, yellowish gray, thickly bedded with iron stained laminae	fine	both dolomite and calcite, porous			8	maybe	39
579	IPq	Snowcrest Mountain	10S	03W	6	ACC		44.99382	-112.0145	TRS	NAD	146	22	Quartz arenite: subdued ledge former, heavily iron stained to grayish orange, massive and maybe bioturbated	fine	calcite			30	maybe	39
580	IPq	Snowcrest Mountain	10S	03W	6	ACC		44.99382	-112.0145	TRS	NAD	146	21	Quartz arenite: ledge former, grayish orange, thickly bedded	fine	calcite			15	maybe	39
581	IPq	Snowcrest Mountain	10S	03W	6	ACC	lower dolomitic interval	44.99382	-112.0145	TRS	NAD	146	20	Quartz arenite: ledge former, light gray, thinly bedded with planar cross beds and trough cross beds	fine	dolomite			10	maybe	39
582	IPq	Snowcrest Mountain	10S	03W	6	ACC		44.99382	-112.0145	TRS	NAD	147	19	Quartz arenite: ledge formers, very pale orange, thickly bedded with faint laminae highlighted by iron stains, locally fractured	fine	dolomite and calcite			46	maybe	39
583	IPq	Snowcrest Mountain	10S	03W	6	ACC		44.99382	-112.0145	TRS	NAD	147	17	Quartz arenite: ledge former, very pale orange, heavily fractured with many surfaces showing slickensides		dolomite, well indurated			18	no	39
584	IPq	Snowcrest Mountain	10S	03W	6	ACC		44.99382	-112.0145	TRS	NAD	147	16	Quartz arenite: poorly exposed series of ledges, thinly bedded, yellowish gray	fine	dolomite			31	maybe	39
585	IPq	Snowcrest Mountain	10S	03W	6	ACC		44.99382	-112.0145	TRS	NAD	147	14	Quartz arenite: ledge former, very pale orange, locally iron stained, medium bedded	fine	dolomite			3	maybe	39
586	IPq	Sliderock Mountain	10S	04W	23	DDC	at the summit of Sliderock Mountain	44.94256	-112.0534	TRS	NAD	150	53	Quartz arenite: clean, resistant ledge forming unit, some iron stains, trough and planar cross beds, yellowish gray to gryaish orange pink.	fine	locally dolomite		well	220	maybe	39
587	IPq	Sliderock Mountain	10S	04W	23	DDC	lower dolomitic interval	44.94256	-112.0534	TRS	NAD	150	51	Quartz arenite: ledge former, very pale orange	very fine	dolomite, very well indurated			15	no	39
588	IPq	Sliderock Mountain	10S	04W	23	DDC		44.94256	-112.0534	TRS	NAD	151	47	Quartz arenite: ledge former, massive mottled on some surfaces and bioturbated, yellowish gray to pale red	very fine	calcite, well indurated			10	no	39
589	IPq	Sliderock Mountain	10S	04W	23	DDC		44.94256	-112.0534	TRS	NAD	151	43	Quartz arenite: resistant ledge former, very pale orange, thinly bedded, relict cross beds.		dolomite			6	maybe	39
590	IPq	Sliderock Mountain	10S	04W	23	DDC		44.94256	-112.0534	TRS	NAD	151	41	Quartz arenite: moderately resistant, very pale orange, smalll chert pods, trough and planar cross beds with fossil fragments	fine	dolomite			15	maybe	39
591	IPq	Sliderock Mountain	10S	04W	23	DDC		44.94256	-112.0534	TRS	NAD	151	37	Quartz arenite: light brownish gray and massive	fine	dolomite		well	7	maybe	39
592	IPq	Sliderock Mountain	10S	04W	23	DDC		44.94256	-112.0534	TRS	NAD	152	34	Quartz arenite: yellowish gray, low angle planar cross beds	fine	dolomite			4	maybe	39
593	IPq	Sliderock Mountain	10S	04W	23	DDC		44.94256	-112.0534	TRS	NAD	152	32	Quartz arenite: resistant ledge former, light brownish gray		dolomite			5	maybe	39
594	IPq	Sliderock Mountain	10S	04W	23	DDC		44.94256	-112.0534	TRS	NAD	152	30	Quartz arenite: very pale orange, thinly bedded with irregular contacts between beds, locally scour and fill structures	medium	dolomite			3	maybe	39
595	IPq	Sliderock Mountain	10S	04W	23	DDC		44.94256	-112.0534	TRS	NAD	152	28	Quartz arenite: intergranular porosity, ledge former, medium bedded with low angle cross beds, very pale orange	fine	dolomite			12	maybe	39
596	IPMs	Sliderock Mountain	10S	04W	23	DDC		44.94256	-112.0534	TRS	NAD	155	4	Quartz arenite: very resistant cliff former, slightly conglomeratic towards the bottom of the unit, very pale orange to light brown.	medium	calcite		moderately well	35	no	39
597	IPMs	Sliderock Mountain	10S	04W	23	DDC		44.94256	-112.0534	TRS	NAD	155	1	Quartz arenite: poorly exposed, yellowish gray, mottled by iron-stained dots	fine	calcite			10	maybe	39

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598	IPq	Spur Mountain	10S	04W	23	BCC	on the NE flank of Spur Mountain	44.94982	-112.0689	TRS	NAD	157	43	Quartz arenite: poorly exposed, massive and bioturbated, yellowish gray,	fine	dolomite			65	maybe	39
599	IPq	Spur Mountain	10S	04W	23	BCC		44.94982	-112.0689	TRS	NAD	157	41	Quartz arenite: ledge former, massive, yellowish gray	fine	dolomite, well indurated			49	no	39
600	IPq	Spur Mountain	10S	04W	23	BCC		44.94982	-112.0689	TRS	NAD	157	39	Quartz arenite: ledge former, massive, yellowish gray	fine	dolomite, well indurated			21	no	39
601	IPq	Spur Mountain	10S	04W	23	BCC		44.94982	-112.0689	TRS	NAD	157	37	Quartz arenite: subdued ledge former, yellowish gray	fine	dolomite			16	maybe	39
602	IPq	Spur Mountain	10S	04W	23	BCC		44.94982	-112.0689	TRS	NAD	158	35	Quartz arenite: ledge former, very light gray to to yellowish gray, massive	fine	calcite			20	maybe	39
603	IPq	Spur Mountain	10S	04W	23	BCC		44.94982	-112.0689	TRS	NAD	158	32	Quartz arenite: ledge former, light gray, massive, undulatory basal contact		dolomite			12	maybe	39
604	IPq	Spur Mountain	10S	04W	23	BCC		44.94982	-112.0689	TRS	NAD	158	30	Quartz arenite: subdued ledge former, thinly bedded, very light gray	fine	calcite			5	maybe	39
605	IPMs	Spur Mountain	10S	04W	23	BCC		44.94982	-112.0689	TRS	NAD	161	1	Quartz arenite: ledge former, very pale orange, hematite stained trough cross bed sets, locally sets contain a basal pebble layer	medium	calcite			10	maybe	39
606	IPq	Hogback Mountain	11S	04W	7	ACA	On overturned, NW flank of Hogback Mountain	44.89416	-112.1343	TRS	NAD	163	40	Quartz arenite: ledge former, yellowish gray, medium bedded	fine	dolomite			20	maybe	39
607	IPMs	Hogback Mountain	11S	04W	7	ACA		44.89416	-112.1343	TRS	NAD	165	10	Quartz arenite: subdued ledge former, pale brown, bioturbated, calcite vugs, faint cross laminations highlighted by iron staining	very fine	calcite			5	no	39
608	IPMs	Hogback Mountain	11S	04W	7	ACA		44.89416	-112.1343	TRS	NAD	166	7	Quartz arenite: poorly exposed, calcite vugs, thinly bedded, light olive gray	fine	calcite			10	maybe	39
609	IPMs	Hogback Mountain	11S	04W	7	ACA		44.89416	-112.1343	TRS	NAD	166	1	Quartz arenite: subdued ledge former, medium bedded with planar cross-bed sets, yellowish gray	fine	calcite			20	maybe	39
610	IPq	Sunset Peak	11S	04W	19	CCC	on eastern flank of Sunset Peak, just below the summit	44.85619	-112.1469	TRS	NAD	168	45	Quartz arenite: cliff former, very light gray to yellowish gray, thickly bedded	fine	silica			110	no	39
611	IPq	Sunset Peak	11S	04W	19	CCC		44.85619	-112.1469	TRS	NAD83		44	Quartz arenite: series of resistant ledge formers, massive to thickly bedded, very pale orange	fine	calcite, local dolomite			101	maybe	39
612	IPq	Sunset Peak	11S	04W	19	CCC	lower dolomitic interval	44.85619	-112.1469	TRS	NAD	168	43	Quartz arenite: ledge former, massive, yellowish gray	fine	dolomite			8	maybe	39
613	IPq	Sunset Peak	11S	04W	19	CCC		44.85619	-112.1469	TRS	NAD83		42	Quartz arenites: calcite , alternating with beds of dolomite, series of ledge formers, very pale orange to yellowish gray	fine	alternating calcite and dolomite			88	no	39
614	IPq	Sunset Peak	11S	04W	19	CCC		44.85619	-112.1469	TRS	NAD	169	38	Quartz arenite: ledge former, massive, very pale orange	fine	dolomite			10	maybe	39
615	IPq	Sunset Peak	11S	04W	19	CCC		44.85619	-112.1469	TRS	NAD	171	6	Quartz arenite: ledge formers, locally hematite stained, interbedded locally with grainstone and pebble limestone conglomerates, light olive gray		calcite			25	no	39
616	IPq	Sawtooth Mountain	12S	05W	9	CAA	on the northern flank of Sawtooth Mountain	44.80415	-112.2206	TRS	NAD	174	33	Quartz arenite: ledge former, grayish orange	fine	dolomite			10	maybe	39
617	IPMs	Sawtooth Mountain	12S	05W	9	CAA		44.80415	-112.2206	TRS	NAD	177	4	Quartz arenite: ledge former, cross laminations highlighted by hematite stains, presence of thin mudstone lenses, lower contact appears erosional, yellowish gray	fine	calcite		moderately well	15	maybe	39
618	IPMs	Sawtooth Mountain	12S	05W	9	CAA		44.80415	-112.2206	TRS	NAD	177	1	Quartz arenite: ledge formers, low angle trough and planar cross beds, hematite staining, lower erosional contact present, olive gray to yellowish gray	fine	calcite, well indurated		moderately well	46	no	39
619	IPq	Red Rock River	13S	07W	22	CBD	on a prominent ridge about two miles to the north of Lima Reservoir Road	44.68616	-112.4492	TRS	NAD	180	39	Quartz arenite: ledge former, medium bedded, light gray	fine	calcite, well indurated			12	no	39

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620	IPq	Red Rock River	13S	07W	22	CBD		44.68616	-112.4492	TRS	NAD	180	37	Quartz arenite: friable, series of ledge formers, yellowish gray, fair prosity, localized heavy mineral layers	fine	silica, friable			100	YES	39
621	IPq	Red Rock River	13S	07W	22	CBD		44.68616	-112.4492	TRS	NAD	180	36	Quartz arenite: ledge formers, relict medium bedding, dark yellowish orange	fine	silica , well indurated			74	no	39
622	IPq	Red Rock River	13S	07W	22	CBD		44.68616	-112.4492	TRS	NAD	180	34	Quartz arenite: partially exposed sequence within a talus field, medium bedded, many surfaces display slickensides, yellowish gray to light brown	fine	silica			413	no	39
623	IPMs	Red Rock River	13S	07W	22	CBD		44.68616	-112.4492	TRS	NAD	183	1	Quartz arenite: friable, poorly exposed, grayish orange, unit speckled by hematite stained dots	fine	calcite , friable			40	yes	39
624	IPq	Big Sheep Creek	13S	10W	36	BBA	NE of Hidden Pasture Creek, on a prominent NW dipping ridge of Dixon Mountain	44.66661	-112.7715	TRS	NAD	185	22	Quartz arenite: friable, series of ledge formers, yellowish gray, hematite stains, porous, medium to thickly bedded with numerous dime-sized concretions	fine	dolomite, friable			57	YES	39
625	IPMs	Big Sheep Creek	13S	10W	36	BBA		44.66661	-112.7715	TRS	NAD	187	7	Quartz arenite: ledge former, hematite stained in areas, medium bedded with fossils and possible bioturbation, yellowish gray	very fine	calcite			5	no	39
626	IPMs	Big Sheep Creek	13S	10W	36	BBA		44.66661	-112.7715	TRS	NAD	187	5	Quartz arenite: ledge former, heavily hematite stained, thinly bedded with some gastropod fossils, moderate yellowish brown	very fine	calcite			10	no	39
627	IPMs	Big Sheep Creek	13S	10W	36	BBA		44.66661	-112.7715	TRS	NAD	187	1	Quartz arenite: small cliff former, massive and heavily fractured with slickensides, very pale orange to hematite stained, moderate brown in the basal portion	fine	calcite			14	no	39
628	Pp	Phosphoria formation	12S	02W	2	C		44.81387	-111.8173	TRS	NAD	151	1	Sandstone: light shades of reddish brown, weathers dark, fossils					17	maybe	40
629	Pp	Phosphoria formation	12S	02W	2	C		44.81387	-111.8173	TRS	NAD	151	3	Quartzitic sandstone: poorly exposed, gray					50	maybe	40
630	Pp	Phosphoria formation	12S	02W	2	C		44.81387	-111.8173	TRS	NAD	151	7	Quartzitic sandstone: contains chert nodules and stringers, light gray and light brown, chert is white to grayish yellow					4	no	40
631	Pp	Phosphoria formation	12S	02W	2	C		44.81387	-111.8173	TRS	NAD	152	12	Quartzitic sandstone: with chert stringers and veins crossing the bedding at right angles, light brown to buff					22	no	40
632	Pp	Phosphoria formation	12S	02W	2	C		44.81387	-111.8173	TRS	NAD	152	14	Quartzitic sandstone: massive conchoidal fracture, light gray to light brown					6	no	40
633	IPq	Quadrant Formation	12S	02W	27		section along the West Fork of the Madison River	44.7596	-111.8324	TRS	NAD	152	1	Sandstone: medium bedded and poorly exposed, yellowish brown, weathers light gray					46	maybe	40
634	IPq	Quadrant Formation	12S	02W	27			44.7596	-111.8324	TRS	NAD	152	3	Sandstone: light shades of reddish brown, weathers dark, fossils					82	maybe	40
635	IPq	Quadrant Formation	12S	02W	27			44.7596	-111.8324	TRS	NAD	153	7	Sandstone: crudely medium bedded, light yellow to light gray to tan	medium	calcareous			7	yes	40
636	Cf	Flathead Formation	12S	01W	31	B	section along the West Fork of the Madison River	44.74879	-111.7763	TRS	NAD	159	1	Sandstone: thin bedded, alternating with thin beds of glauconitic tan sandstone and green shales					19	no	40
637	Cf	Flathead Formation	12S	01W	31	B	section along the West Fork of the Madison River	44.74879	-111.7763	TRS	NAD	159	2	Quartzitic sandstone: buff, medium bedded, cross bedded, intercalated with few thin green shale beds					35	maybe	40
638	Cf	Flathead Formation	12S	01W	31	B	section along the West Fork of the Madison River	44.74879	-111.7763	TRS	NAD	159	3	Quartzitic sandstone: thin to thick bedded, clear quartz pebbles common at base of unit, rusty yellow brown to dark red and dark gray, weathers darker					76	maybe	40
639	Kk	Kootenai Formation: Early Cretaceous	09S	02E	13	AA	NE of Tumbledown Creek	45.05573	-111.4157	TRS	NAD	148	1	Sandstone: thin interbeds of siltstone, ripple marks, pinkish brown when fresh, weathers yellow buff to gray	very fine				12.6	no	41
640	Kk	Kootenai Formation: Early Cretaceous	09S	02E	13	AA		45.05573	-111.4157	TRS	NAD	148	2	Quartz arenite: thicker beds at the top, ripple marks, mud cracks and wood fragments, weathers yellow	very fine				45	no	41
641	Kk	Kootenai Formation: Early Cretaceous	09S	02E	13	AA		45.05573	-111.4157	TRS	NAD	149	9	Sandstone: conglomeratic in places, cross-laminated, brown phosphatic sandstone is present near the middle, weathers yellow buff.	very fine	calcareous			33.7	no	41

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642	Kk	Kootenai Formation: Early Cretaceous	09S	02E	13	AA		45.05573	-111.4157	TRS	NAD	149	10	Quartzose sandstone: scattered black chert pebbles, fractured, forms slopes, weathers yellowish-tan	medium	calcareous			5.2	no	41
643	IPq	Quadrant Formation: Pennsylvanian	09S	04E	3	B	W. of U.S. Highway 191 at Pulpit Rock	45.08345	-111.225	TRS	NAD	158	1	Quartz arenite: top 1' not calcareous, white	very fine	calcareous			11.7	no	41
644	IPq	Quadrant Formation: Pennsylvanian	09S	04E	3	B		45.08345	-111.225	TRS	NAD	158	2	Sandstone: cross-laminated with current movement from north to south, fractured at right angles to the bedding, dirty white	very fine	noncalcareous, porous			39	no	41
645	IPq	Quadrant Formation: Pennsylvanian	09S	04E	3	B		45.08345	-111.225	TRS	NAD	159	3	Sandstone: white		slightly calcareous			32.2	maybe	41
646	IPq	Quadrant Formation: Pennsylvanian	09S	04E	3	B		45.08345	-111.225	TRS	NAD	159	4	Sandstone: well cross bedded, some iron concretions, white		calcareous			40	maybe	41
647	IPq	Quadrant Formation: Pennsylvanian	09S	04E	3	B		45.08345	-111.225	TRS	NAD	159	5	Sandstone: yellowish-white	very fine	calcareous		well	22.5	no	41
648	IPq	Quadrant Formation: Pennsylvanian	09S	04E	3	B		45.08345	-111.225	TRS	NAD	159	6	Sandstone: cross laminated, bedding lines visible due to weathering and solution, white		calcareous			41.8	maybe	41
649	IPq	Quadrant Formation: Pennsylvanian	09S	04E	3	B		45.08345	-111.225	TRS	NAD	159	7	Sandstone: cross laminated, scattered chert nodules, 4' cavernous at base, calcareous sandstone with cacite filled voids, grayish-white, weathers yellow buff	very fine	calcareous			34	no	41
650	Cf	Flathead Formation: Early Middle Cambrian	09S	02E	25	B	S. of Taylor Fork	45.02499	-111.4286	TRS	NAD	170	2	Quartztic sandstone: glauconitic, pinkish	fine	calcareous			1.2	no	41
651	Cf		09S	02E	25	B	S. of Taylor Fork	45.02499	-111.4286	TRS	NAD	170	4	Quartz arenite: limonitic, glauconitic, glauconite forms laminations	fine to medium	calcareous			1.3	maybe	41
652	Cf		09S	02E	25	B	S. of Taylor Fork	45.02499	-111.4286	TRS	NAD	170	6	Quartz arenite: limonitic, glauconitic, cross bedded, coarser grains found in lenses	fine	calcareous	subangular to rounded		3	maybe	41
653	Cf		09S	02E	25	B	S. of Taylor Fork	45.02499	-111.4286	TRS	NAD	170	8	Quartz arenite: lode casts present, with green micaceous shale interbeds, orange buff	very fine	calcareous			2	no	41
654	Cf		09S	02E	25	B	S. of Taylor Fork	45.02499	-111.4286	TRS	NAD	170	11	Sandstone: deep red, contains small lenses of buff-green sandstone	very fine	calcareous			2.3	no	41
655	Cf		09S	02E	25	B	S. of Taylor Fork	45.02499	-111.4286	TRS	NAD	170	12	Sandstone: buff, grades above and below into deep red sandstone	very fine	calcareous			1	no	41
656	Cf		09S	02E	25	B	S. of Taylor Fork	45.02499	-111.4286	TRS	NAD	170	13	Sandstone: deep red, grades laterally into green and buff sandstones	very fine	calcareous			0.3	no	41
657	Cf		09S	02E	25	B	S. of Taylor Fork	45.02499	-111.4286	TRS	NAD	170	14	Quartz arenite: scattered amber quartzite pebbles at base, scattered green clay, orange buff	very fine	calcareous			0.5	no	41
658	IPt	Locality III	09S	04E	18	BD	In the north valley wall of Taylor Fork over one and one quarter miles from its junction with the Gallatin	45.05213	-111.2831	TRS	NAD	32	6	Sandstone: prominent cliff former, gray to buff with small black specks, weathers medium to dark brown					2.5	no	42
659	IPt	Locality III	09S	04E	18	BD		45.05213	-111.2831	TRS	NAD	32	5	Sandstone: interbedded with chert, cliff former, medium to light brown with small black specks, weathers medium brown	fine				5	no	42
660	IPt	Locality III	09S	04E	18	BD		45.05213	-111.2831	TRS	NAD	32	2	Sandstone: numerous magnetite (?) grains, hackly fracture and lots of chert nodules and veins, chert layering at base, cliff former, light gray, weathers buff to light gray with some iron staining	fine	calcareous			18	no	42
661	IPt	Locality III	09S	04E	18	BD		45.05213	-111.2831	TRS	NAD	32	1	Sandstone: blocky fracture-talus former, light gray weathers yellow gray with yellow and brown iron stains	fine	dense, calcareous			24	maybe	42

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662	IPt	Locality II	09S	04E	18	BD	In the north valley wall of Taylor Fork over one and one quarter miles from its junction with the Gallatin	45.05213	-111.2831	TRS	NAD	33	5	Sandstone: blocky fracture-talus former, light gray weathers yellow gray with yellow and brown iron stains	fine	dense, calcareous			24	maybe	42
663	IPt	Locality II	09S	04E	18	BD		45.05213	-111.2831	TRS	NAD	33	4	Quartzite: cliff former, blocky fracture with part of section covered by talus, yellow gray, weathers gray-buff	fine				30	no	42
664	IPt	Locality II	09S	04E	18	BD		45.05213	-111.2831	TRS	NAD	33	3	Sandstone: blocky fracture, cliff former, yellow to tan, weathers buff to gray	medium	calcareous, porous			15	yes	42
665	IPt	Locality II	09S	04E	18	BD		45.05213	-111.2831	TRS	NAD	33	2	Quartzite: cliff former, blocky fracture, iron stains, light gray, weathers gray	fine				21	no	42
666	Kk	Locality VII	09S	04E	18	BAC	The north wall of Taylor Fork Valley about one quarter mile east of the junction of Taylor Fork and Wapiti Creek and about 100 ft above the low water level.	45.05491	-111.2843	TRS	NAD	67	10	Sandstone: limonite present, speckled appearance, poorly bedded, cliff former, light yellow gray		thin and flaggy near middle			8	maybe	42
667	Kk		09S	04E	18	BAC		45.05491	-111.2843	TRS	NAD	68	7	Sandstone: even grained with poorly defined bedding, limonite stains, surface pitted with some limonite concretions, yellowish gray, weathers reddish brown	fine				15.5	maybe	42
668	Kk		09S	04E	18	BAC		45.05491	-111.2843	TRS	NAD	68	4	Sandstone: even textured, cross bedded, small to large interbedded lenses of conglomerate, cliff former, gray, black speckled		very calcareous			9	no	42
669	Kk		09S	04E	18	BAC		45.05491	-111.2843	TRS	NAD	69	2	Sandstone: even textured, cross bedded, small lenses of conglomerate, 4" layer of white sandstone at 5'4", otherwise gray with black speckles	very fine	very calcareous			5.5	no	42
670	IPq	Buck Creek Canyon section	08S	03E	13		Well exposed along both sides of the creek where it juts through the steep southwestern flank of the Buck Creek Ridge, an asymmetric anticline	45.13742	-111.3008	TRS	NAD	196	34	Sandstone: clean, quartz grains clear and sparkly, thin bedded, fractured, white mottled with buff and pink	fine	non-calcareous		well	28	yes	43
671	IPq	Buck Creek Canyon section	08S	03E	13			45.13742	-111.3008	TRS	NAD	196	32	Sandstone: medium bedded, clean and sparkly clear quartz grains, buff to pink	fine	calcareous		well	8	yes	43
672	IPq	Buck Creek Canyon section	08S	03E	13			45.13742	-111.3008	TRS	NAD	196	30	Sandstone: clear quartz grains, thick bedded, pink to tan	fine	non-calcareous, hard	subangular to subrounded	poorly	3	no	43
673	IPq	Buck Creek Canyon section	08S	03E	13			45.13742	-111.3008	TRS	NAD	197	28	Sandstone: clear quartz grains, thick to very thick bedded, very cross bedded, tan to white	fine	siliceous	subangular	poorly	19.5	maybe	43
674	IPq	Buck Creek Canyon section	08S	03E	13			45.13742	-111.3008	TRS	NAD	197	26	Sandstone: weathers pitted, forms rounded ledge, buff to yellow to white	fine	calcareous			2	maybe	43
675	IPq	Buck Creek Canyon section	08S	03E	13			45.13742	-111.3008	TRS	NAD	197	24	Sandstone: light yellowish-tan to rusty brown, occasionally light pink	very fine	hard resistant, forms cliff			16	no	43
676	IPq	Buck Creek Canyon section	08S	03E	13			45.13742	-111.3008	TRS	NAD	197	22	Sandstone: very porous, frosted quartz grains, medium to thick bedded, cross bedded, tan to buff or white	very fine to medium	calcareous at base, friable to hard, very porous	sub-rounded to sub-angular	poorly	19	yes	43

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677	IPq	Buck Creek Canyon section	08S	03E	13			45.13742	-111.3008	TRS	NAD	197	19	Sandstone: buff to tan	fine	very calcareous, friable to resistant		moderately well	1.8	maybe	43
678	IPq	Buck Creek Canyon section	08S	03E	13			45.13742	-111.3008	TRS	NAD	197	17	Sandstone: clean, clear quartz grains, medium to thick bedded, forms cliff, buff to yellowish white	fine	resistant, calcareous	subrounded to well rounded		6	maybe	43
679	Kk	Porcupine Ridge section	07S	04E	21		The formations are exposed on the southwest slope of the ridge which is immediately NE of the	45.21024	-111.2405	TRS	NAD	199	44	Sandstone: massive, lower 5 ' contain lenses of gray shale, white to rust	fine				30.5	no	43
680	Kk	Porcupine Ridge section	07S	04E	21			45.21024	-111.2405	TRS	NAD	200	43	Sandstone: alternating with subordinate amount of blocky brown shale, gray at bottom speckled with rust at the top					8	no	43
681	Kk	Porcupine Ridge section	07S	04E	21			45.21024	-111.2405	TRS	NAD	200	42	Sandstone: massive, gray, weathers purple with thin beds of white blocky shale	fine				8	no	43
682	Kk	Porcupine Ridge section	07S	04E	21			45.21024	-111.2405	TRS	NAD	200	40	Sandstone: poorly exposed, gray brown and speckled with black	very fine				2.5	no	43
683	Kk	Porcupine Ridge section	07S	04E	21			45.21024	-111.2405	TRS	NAD	200	39	Sandstone: massive, gray to white with rusty spots	fine	silica			5	no	43
684	Kk	Porcupine Ridge section	07S	04E	21			45.21024	-111.2405	TRS	NAD	200	38	Sandstone: gray, silty and thin bedded, alternating with blue/gray fissile shale	fine				4.5	no	43
685	Kk	Porcupine Ridge section	07S	04E	21			45.21024	-111.2405	TRS	NAD	200	37	Sandstone: alternates with gray-brown fissile shale, gray, weathers red	fine				10	no	43
686	Kk	Porcupine Ridge section	07S	04E	21			45.21024	-111.2405	TRS	NAD83		36	Sandstone: 'salt and pepper', some rusty spots, medium bedded, white to gray	fine				2	no	43
687	Kk	Porcupine Ridge section	07S	04E	21			45.21024	-111.2405	TRS	NAD83		35	Sandstone: thin bedded, platy fracture, rusty red alternating with beds and lenses of blue-gray and red platy to fissile shale	fine	silica			8	no	43
688	Kk	Porcupine Ridge section	07S	04E	21			45.21024	-111.2405	TRS	NAD	201	19	Sandstone: gray to white	fine				2	no	43
689	Kk	Porcupine Ridge section	07S	04E	21			45.21024	-111.2405	TRS	NAD	201	9	Sandstone: white and thick bedded, weathers yellow	fine				5	no	43
690	Kk	Porcupine Ridge section	07S	04E	21			45.21024	-111.2405	TRS	NAD	201	7	Sandstone: limy	fine				2	no	43
691	Kk	Porcupine Ridge section	07S	04E	21			45.21024	-111.2405	TRS	NAD	201	4	Sandstone: 'salt and pepper', lenses of chert pebble conglomerate present, gray	medium				7.5	no	43
692	Kk	Porcupine Ridge section	07S	04E	21			45.21024	-111.2405	TRS	NAD	201	3	Sandstone: lenses of conglomerate, light gray to white	fine to medium				13.5	no	43
693	IPq	Southeast Cinnamon Mountain section	08S	04E	21		on the SW limb of the Buck Creek Anticline as exposed on the southwest end of Cinnamon Mountain	45.12348	-111.2404	TRS	NAD	205	40	Sandstone: cross bedded and massively bedded, forms prominent cliff, gray and light yellow to buff,	fine	calcareous, resistant	rounded		36	maybe	43
694	IPq	Southeast Cinnamon Mountain section	08S	04E	21			45.12348	-111.2404	TRS	NAD	205	39	Sandstone: clean, medium bedded, buff	fine	porous, non resistant			27	yes	43
695	IPq	Southeast Cinnamon Mountain section	08S	04E	21			45.12348	-111.2404	TRS	NAD	205	38	Sandstone: massively bedded, specks of hematite, red and light pink to yellow	fine	porous, non-calcareous			22	maybe	43

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696	IPq	Southeast Cinnamon Mountain section	08S	04E	21			45.12348	-111.2404	TRS	NAD	205	36	Sandstone: specks of hematite (red) and limonite (yellow), heavily cross bedded, light pink to yellow	fine	porous, non-calcareous			29.5	maybe	43
697	IPq	Southeast Cinnamon Mountain section	08S	04E	21			45.12348	-111.2404	TRS	NAD	205	35	Sandstone: clean, medium bedded, light brown to yellow	fine to medium	calcareous	subangular		12.5	yes	43
698	IPq	Southeast Cinnamon Mountain section	08S	04E	21			45.12348	-111.2404	TRS	NAD	205	33	Sandstone: clean, massive, light tan	fine	resistant and calcareous			2	maybe	43
699	IPq	Southeast Cinnamon Mountain section	08S	04E	21			45.12348	-111.2404	TRS	NAD	205	32	Sandstone: friable, clean, thin bedded, cross bedded, light tan to ivory, weathers white	fine	friable			4	yes	43
700	IPq	Southeast Cinnamon Mountain section	08S	04E	21			45.12348	-111.2404	TRS	NAD	205	31	Sandstone: friable, clean, cross bedded, massive, yellow to tan	fine	very calcareous, friable			7	yes	43
701	IPq	Southeast Cinnamon Mountain section	08S	04E	21			45.12348	-111.2404	TRS	NAD	205	29	Sandstone: vbery porous, clean, massive, very crossbedded, tan	fine	slightly calcareous, very porous			15	yes	43
702	IPq	Southeast Cinnamon Mountain section	08S	04E	21			45.12348	-111.2404	TRS	NAD	205	23	Sandstone: massive, very cross bedded, light buff, weathers to medium gray	very fine	calcareous	rounded		4	no	43
703	IPq	Southeast Cinnamon Mountain section	08S	04E	21			45.12348	-111.2404	TRS	NAD	205	19	Sandstone: light tan		calcareous at base			1.5	no	43
704	IPq	Southeast Cinnamon Mountain section	08S	04E	21			45.12348	-111.2404	TRS	NAD	205	17	Sandstone: clean, thick bedded, light tan, buff, or yellowish gray	fine	calcareous			5	yes	43
705	IPq	Southeast Cinnamon Mountain section	08S	04E	21			45.12348	-111.2404	TRS	NAD	205	15	Sandstone: clean, thick bedded, light gray	fine	calcareous		well	3	yes	43
706	IPq	Southeast Cinnamon Mountain section	08S	04E	22		on the southwest limb of the Buck Creek Anticline as exposed on the SW end of Cinnamon Mountain	45.1237	-111.2199	TRS	NAD	205	40	Sandstone: cross bedded and massively bedded, forms prominent gray cliff, light yellow to buff	fine	calcareous, resistant	rounded		36	yes	43
707	IPq	Southeast Cinnamon Mountain section	08S	04E	22			45.1237	-111.2199	TRS	NAD	205	39	Sandstone: clean, porous, medium bedded, buff	fine	porous, non resistant			27	yes	43
708	IPq	Southeast Cinnamon Mountain section	08S	04E	22			45.1237	-111.2199	TRS	NAD	205	38	Sandstone: porous, massively bedded, specks of hematite (red) and limonite (yellow), light pink to yellow	fine	porous, non-calcareous			22	maybe	43
709	IPq	Southeast Cinnamon Mountain section	08S	04E	22			45.1237	-111.2199	TRS	NAD	205	36	Sandstone: porous, specks of hematite (red) and limonite (yellow), heavily cross bedded, light pink to yellow	fine	porous, non-calcareous			29.5	maybe	43
710	IPq	Southeast Cinnamon Mountain section	08S	04E	22			45.1237	-111.2199	TRS	NAD	205	35	Sandstone: clean, medium bedded, light brown to yellow	fine to medium	calcareous	subangular		12.5	maybe	43
711	IPq	Southeast Cinnamon Mountain section	08S	04E	22			45.1237	-111.2199	TRS	NAD	205	33	Sandstone: clean, massive, light tan	fine	resistant and calcareous			2	maybe	43
712	IPq	Southeast Cinnamon Mountain section	08S	04E	22			45.1237	-111.2199	TRS	NAD	205	32	Sandstone: clean, friable, thin bedded, cross bedded, light tan to ivory, weathers white	fine	friable			4	yes	43

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713	IPq	Southeast Cinnamon Mountain section	08S	04E	22			45.1237	-111.2199	TRS	NAD	205	31	Sandstone: clean, friable, cross bedded to massive, yellow to tan	fine	very calcareous, friable			7	yes	43
714	IPq	Southeast Cinnamon Mountain section	08S	04E	22			45.1237	-111.2199	TRS	NAD	205	29	Sandstone: clean, very porous, massive to very crossbedded, tan	fine	slightly calcareous, very porous			15	yes	43
715	IPq	Southeast Cinnamon Mountain section	08S	04E	22			45.1237	-111.2199	TRS	NAD	205	23	Sandstone: very cross bedded to massive, light buff weathers to medium gray	very fine	calcareous	rounded		4	no	43
716	IPq	Southeast Cinnamon Mountain section	08S	04E	22			45.1237	-111.2199	TRS	NAD	205	19	Sandstone: light tan		calcareous at base			1.5	maybe	43
717	IPq	Southeast Cinnamon Mountain section	08S	04E	22			45.1237	-111.2199	TRS	NAD	205	17	Sandstone: clean, thick bedded, light tan, buff, or yellowish gray	fine	calcareous			5	yes	43
718	IPq	Southeast Cinnamon Mountain section	08S	04E	22			45.1237	-111.2199	TRS	NAD	205	15	Sandstone: clean, thick bedded, light gray	fine	calcareous		well	3	yes	43
719	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23		measured on both sides of Taylor Fork about one mile upstream from Taylor Falls	45.03568	-111.444	TRS	NAD	206	159	Sandstone: clean frosted quartz grains, thick bedded, finely laminated, cross-bedded, weathers into a smooth rounded cliff, white to light yellow	medium	very porous, lossely with calcite and clay	rounded	well	26.5	yes	43
720	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	206	158	Sandstone: unevenly bedded, blocky weathered surface, tan	fine	very calcareous, argillaceous, non-resistant			1.5	maybe	43
721	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	206	157	Sandstone: clean, medium to thick bedded, cross-bedded, tan to buff to ivory and white	fine	non-calcareous at top to cacareous at bottom	rounded		36.5	yes	43
722	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	206	156	Sandstone: thick bedded to massive, cross bedded, buff, weathers tan to gray	fine	very calcareous			16	yes	43
723	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	206	154	Sandstone: porous, thin to thick bedded, cross bedded, buff to white and pink	fine	porous, clay	subangular to subrounded		35	yes	43
724	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	209	152	Sandstone: medium bedded, buff	fine	very calcareous, resistant			2	no	43
725	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	209	150	Sandstone: dolomitic at base, medium to thin bedded, white to light brown, weathers buff to yellow	fine	very hard to friable			5.5	maybe	43
726	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	209	148	Sandstone: medium bedded, light yellow to white	fine	calcareous, rather non-resistant			6	yes	43

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727	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	209	144	Sandstone: medium bedded and grades into limestone unit above, light tan or buff	fine	very calcareous			2	maybe	43
728	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	209	143	Sandstone: friable, pale green	fine	non-calcareous, friable			1	yes	43
729	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	209	142	Sandstone: hard, some white chert lenses and cavities lined with large calcite crystals, buff to gray-brown	very fine	very calcareous, resistant			2.3	no	43
730	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	209	140	Sandstone: bioturbated, very resistant, buff	fine to coarse near bottom	calcareous			1.5	no	43
731	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	222	5	Sandstone: very thinly bedded, unevenly bedded, bright green and black grains, and numerous limonitic orange grains, greenish gray to orange gray	fine	calcareous		poorly	4	no	43
732	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	222	3	Sandstone: cross bedded, medium to thin bedded with ripple marks and worm trails, glauconite, mottled white and tan or medium brown, weathers dull green in many places	medium to coarse	calcareous, porous	well rounded	poorly	16	yes	43
733	IPq	Taylor Basin Composite Paleozoic section	09S	02E	23			45.03568	-111.444	TRS	NAD	222	2	Quartzitic sandstone: micaceous, poorly exposed, tan to light green	very fine				11	no	43
734	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24		Measured on both sides of Taylor Fork about one mile upstream from Taylor Falls	45.0358	-111.4234	TRS	NAD	206	159	Sandstone: clean frosted quartz grains, very porous, thick bedded, finely laminated, cross-bedded, weathers into a smooth rounded cliff, white to light yellow	medium	very porous, loosely with calcite and clay	rounded	well	26.5	yes	43
735	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	206	158	Sandstone: unevenly bedded, blocky weathered surface, tan	fine	very calcareous, argillaceous, non-resistant			1.5	yes	43
736	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	206	157	Sandstone: clean, medium to thick bedded, cross-bedded, tan to buff to ivory and white	fine	non-calcareous at top to calcareous at bottom	rounded		36.5	yes	43
737	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	206	156	Sandstone: thick bedded to massive, cross bedded, buff, weathers tan to gray	fine	very calcareous			16	yes	43
738	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	206	154	Sandstone: porous, thin to thick bedded, cross bedded, buff to white and pink	fine	porous, clay	subangular to subrounded		35	yes	43

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739	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	209	152	Sandstone: medium bedded, buff,	fine	very calcareous, resistant			2	no	43
740	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	209	150	Sandstone: dolomitic at base, medium to thin bedded, white to light brown, weathers buff to yellow	fine	very hard to friable			5.5	maybe	43
741	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	209	148	Sandstone: medium bedded, light yellow to white	fine	calcareous, rather non-resistant			6	yes	43
742	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	209	144	Sandstone: medium bedded, grades into overlying limestone, light tan or buff	fine	very calcareous			2	maybe	43
743	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	209	143	Sandstone: friable, pale green	fine	non-calcareous, friable			1	yes	43
744	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	209	142	Sandstone: hard, some white chert lenses and cavities lined with large calcite crystals, buff to gray-brown	very fine	very calcareous, resistant			2.3	no	43
745	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	209	140	Sandstone: bioturbated, very resistant, buff	fine to coarse near bottom	calcareous, very resistant			1.5	no	43
746	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	222	5	Sandstone: very thinly bedded, unevenly bedded, bright green, black, and numerous limonitic orange grains, greenish gray to orange gray	fine	calcareous		poorly	4	no	43
747	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	222	3	Sandstone: cross bedded, medium to thin bedded with ripple marks and worm trails, glauconitic, mottled white and tan or medium brown, weathers dull green in many places	medium to coarse	calcareous, porous	well rounded	poorly	16	yes	43
748	IPq	Taylor Basin Composite Paleozoic section	09S	02E	24			45.0358	-111.4234	TRS	NAD	222	2	Quartzitic sandstone: micaceous, poorly exposed, tan to light green	very fine				11	no	43
	Jme	Quartzite Gulch	18N	18E	18	BC	Quartzite Gulch	47.32584	-109.4854			44	1	Sandstone: friable, gray		friable			4.4	yes	
	Jme	Quartzite Gulch	18N	18E	18	BC		47.32584	-109.4854			44	2	Sandstone: flaggy, brown					3.3	maybe	
	Jme	Quartzite Gulch	18N	18E	18	BC		47.32584	-109.4854			44	3	Sandstone: gray		very soft			4	maybe	
	Jme	Quartzite Gulch	18N	18E	18	BC		47.32584	-109.4854			44	4	Sandstone: brown showing oxidation banding		very hard			4	no	
	Jme	Quartzite Gulch	18N	18E	18	BC		47.32584	-109.4854			44	5	Sandstone: ferruginous sandstone, gray		soft			2	maybe	
	Jme	Quartzite Gulch	18N	18E	18	BC		47.32584	-109.4854			44	6	Sandstone: brown with oxidation banding		hard			1	no	
	Jme	Quartzite Gulch	18N	18E	18	BC		47.32584	-109.4854			44	7	Sandstone: gray					1	no	
	Jme	Quartzite Gulch	18N	18E	18	BC		47.32584	-109.4854			44	8	Sandstone: gray		soft			6	maybe	
	Jme	Quartzite Gulch	18N	18E	18	BC		47.32584	-109.4854			44	9	Sandstone: thin bedded, feruginous					24	no	
	Jme	Quartzite Gulch	18N	18E	18	BC		47.32584	-109.4854			44	14	Sandstone: fossiliferous sandstone, brown					0.2	no	
	Kk	section of the Kootenai formation	18N	18E	32	BB	E. slope of South Moccasin Mountains. North Kendall Rd.	47.28723	-109.4671			47		Sandstone: conglomeratic, light colored	coarse				10	no	
	Kk	section of the Kootenai formation	18N	18E	32	BB		47.28723	-109.4671			47		Sandstone: cross bedded, white		soft			12	maybe	
	Kk	section of the Kootenai formation	18N	18E	32	BB		47.28723	-109.4671			47		Sandstone: no description					3	maybe	

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	Kk	section of the Kootenai formation	18N	18E	32	BB		47.28723	-109.4671			47		Sandstone: no description					2	maybe	
	Kk	section of the Kootenai formation	18N	18E	32	BB		47.28723	-109.4671			47		Sandstone: cross-bedded, light colored	medium				18	maybe	
	Kk	section of the Kootenai formation	18N	18E	32	BB		47.28723	-109.4671			47		Sandstone: lower 3 ft contain small clay balls, light colored					15	no	
	Kk	section of the Kootenai formation	18N	18E	32	BB		47.28723	-109.4671			47		Sandstone: thinly bedded					10	no	
	Kk	section of the Kootenai formation	18N	18E	32	BB		47.28723	-109.4671			47		Sandstone: massive, light gray	fine	calcareous at top			6	maybe	
	Kk	section of the Kootenai formation	18N	18E	32	BB		47.28723	-109.4671			47		Sandstone: white	medium	soft			3	yes	
	Kk	section of the Kootenai formation	18N	18E	32	BB		47.28723	-109.4671			47		Sandstone: pebbles primarily feldspathic with few dark limestone bits up to 1" thick	coarse to pebbly				1	no	
	Kk	section of the Kootenai formation	18N	18E	32	BB		47.28723	-109.4671			47		Sandstone: cross-bedded, gray	coarse to pebbly				60	no	
	Kk	section of the Kootenai formation	18N	18E	32	BB		47.28723	-109.4671			47		Sandstone: iron stained		calcareous			1	maybe	
	Cf	Mill Creek section					two miles east of the junction of U.S. Forest Services trail no. 55 and Mill Creek Road					85		Quartzite: massive, ledgy slope, very pale orange	fine	silica			17	maybe	
	Cf	Mill Creek section					two miles east of the junction of U.S. Forest Services trail no. 55 and Mill Creek Road					86		Quartz sandstone: massive, straight cliff, lower contact gradational	fine				9	maybe	
	Cf	Mill Creek section					two miles east of the junction of U.S. Forest Services trail no. 55 and Mill Creek Road					87		Quartzite: massive, ledgy slope, lower contact gradational, grayish orange with moderate red mottles	medium	limonitic, siliceous matrix	subangular to subrounded		27	maybe	
	Cf	Mill Creek section					two miles east of the junction of U.S. Forest Services trail no. 55 and Mill Creek Road					88		Quartzite : ledgy slope, lower contact gradational, pale red to interbedded grayish pink and pale red	medium	siliceous matrix	subrounded		16	no	
	Cf	Mill Creek section					two miles east of the junction of U.S. Forest Services trail no. 55 and Mill Creek Road					89		Quartzite: very thin bedded, straight cliff, lower content gradational, pale brown to grayish orange with pale brown mottles	fine to medium		subrounded		21	no	
	Cf	Mill Creek section					two miles east of the junction of U.S. Forest Services trail no. 55 and Mill Creek Road					90		Quartzite: pale reddish brown to grayish orange, cross bedded, ledgy slope, lower contact sharp, irregular, and unconformable	fine to medium		subrounded		18	no	
	IPq	Quadrant	02N	02W	2	CC	about 40 miles E. of Butte and 15 miles N. of I-90 on Hwy 69, between Doherty Mountain/ Cardwell Hill and Devils fence	45.9472	-111.8225			16		Quartzite: no description		resistant			330	no	
	IPq	Quadrant	02N	02W	3	CB		45.95383	-111.8448			16		Quartzite: no description		resistant			331	no	

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	lPq	Quadrant	01N	11W	18	AD	exposed in a bluff directly west of the mouth of Triangle Gulch and at a locality one mile south of Dickie Bridge.	45.83979	-113.01			56		Quartzite: vitreous, heavily fractured, forms conspicuous ridges and large talus slopes; reddish, yellow to buff	medium	well			800	no	
	lPq	Quadrant	01S	10W	17	DA	Quartz Hill road	45.7491	-112.8601			56		Quartzite: clean, vitreous, white					800	no	
	Cf	Flathead Formation	03N	03E	27	BD	South Branch of E. end of Big Davis Gulch	45.98578	-111.341			24	1	Sandstone: moderately glauconitic, cross-bedded, partially covered at contact with overlying Wolsey Formation, light brown	medium	very limonitic			1.8	no	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	4	Quartzite: crossbedded, glauconitic (more so towards the top), several shaly partings, tan	fine	limonitic			22.8	no	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	5	Quartzite: interbedded limonitic and glauconitic beds, fissile micaceous shales included, tan to moderate red, green	fine to medium	varies			1.7	no	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	6	Quartzite: clear grains, crossbedded, limonite speckled, glauconitic, weathers yellowish brown					15	no	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	7	Quartzose sandstone: micaceous shales present in partings, green					2.6	no	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	8	Quartz sandstone: grains speckled with limonite					11.3	maybe	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	9	Quartz sandstone: with limonite spots, green shale partings between 2-3" thick common			subrounded	fairly well	3.9	maybe	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	10	Sandstone: noticeable limonite specks, pale olive	medium to coarse	glauconitic	subrounded	fairly well	2.8	maybe	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	11	Sandstone: light brown to light tan,	medium to coarse				3.3	maybe	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	12	Sandstone: noticeable limonite specks, pale olive	coarse	glauconitic	subangular to subrounded	poor to fair	1.2	maybe	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	13	Quartzite: massive with crossbedding, yellowish gray and pale red-brown					18.8	no	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	14	Sandstone: light olive to yellowish gray with moderate red streaks and bands	medium, locally conglomer.	more friable than above sandstone	subangular to subrounded		1.2	maybe	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	15	Quartzitic sandstone: with pale reddish brown streaks					8.5	maybe	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	16	Sandstone: micaceous shale partings, yellowish gray with green		slightly limonitic			0.9	no	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	17	Sandstone: quartz granules and pebbles to 10 mm					3.3	no	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	18	Sandstone: thin, micaceous, slightly glauconitic, pale olive					0.1	no	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	19	Sandstone: interbedded with rusty-streaked sandstone, light tan	coarse		subrounded to rounded	fairly well	4.4	maybe	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	20	Quartzite: iron stained, locally corssbedded, moderate yellowish brown	conglomeratic				0.4	no	
	Cf	Flathead Formation	03N	03E	27	BD		45.98578	-111.341			24	21	Quartzose sandstone	conglomeratic	coarse grained matrix	Subrounded		5.2	maybe	

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	IPMa	Amsden Formation	03N	03E	35	BAB	NE of beacon	45.97509	-111.3161			59	4	Sandstone: grayish yellow		calcareous, breaks easily in fingers		poorly	2.5	maybe	
	IPMa	Amsden Formation	03N	03E	35	BAB		45.97509	-111.3161			60	23	Sandstone: grayish-red, massive, hematitic	very fine		angular to subangular		1.5	no	
	IPMa	Amsden Formation	03N	03E	35	BAB		45.97509	-111.3161			60	26	Quartzose sandstone: porous, massive, hematitic, grayish red	medium to fine	porous	subangular to angular		13.9	yes	
	IPMa	Amsden Formation	03N	03E	35	BAB		45.97509	-111.3161			60	27	Quartzose sandstone: massive, thick bedded, cross bedded, hematitic, variegated pale red-purple and grayish-red-purple	medium	slightly calcareous	subangular	fairly well	19.9	maybe	
	IPMa	Amsden Formation	03N	03E	35	BAB		45.97509	-111.3161			61	28	Sandstone: porous, hematitic; light pale red		calcareous, porous		fairly well	2.6	yes	
	IPMa	Amsden Formation	03N	03E	35	BAB		45.97509	-111.3161			61	29	Quartzose sandstone: partially covered at base, pale red	medium	porous	subangular		12.1	maybe	
	IPq	Quadrant Formation	03N	03E	35	CCC	S. of Beacon	45.9631	-111.3268			62	1	Quartzite: grayish-white, in contact with Phosphoria	fine				2	no	
	IPq	Quadrant Formation	03N	03E	35	CCC		45.9631	-111.3268			62	2	Sandstone: exhibits local cross bedding, yellowish gray	fine		subangular	fairly well	9.5	maybe	
	IPq	Quadrant Formation	03N	03E	35	CCC		45.9631	-111.3268			62	3	Quartzitic sandstone: medium to thick bedded, cross bedding, yellowish white, weathers yellow gray	fine	poor porosity			31.2	no	
	IPq	Quadrant Formation	03N	03E	35	CCC		45.9631	-111.3268			62	4	Sandstone: porous, cross-bedded, weathers yellowish brown	medium	porous	subangular	fair	2.4	maybe	
	IPq	Quadrant Formation	03N	03E	35	CCC		45.9631	-111.3268			63	5	Sandstone: locally cross bedded, moderate brown to yellowish white, weathers yellowish gray	fine	contains very little cementing material	subangular	fairly well	9.2	maybe	
	IPq	Quadrant Formation	03N	03E	35	CCC		45.9631	-111.3268			63	6	Quartzitic sandstone: clean grayish-white, weathers greenish-yellow stain	fine				9.8	maybe	
	IPq	Quadrant Formation	03N	03E	35	CCC		45.9631	-111.3268			63	7	Quartz sandstone: weathers light grayish yellow to brownish gray	fine				2.7	maybe	
	IPq	Quadrant Formation	03N	03E	35	CCC		45.9631	-111.3268			63	9	Quartzitic sandstone: grayish white with light brown limonite specks throughout,weathers yellowish brown to greenish brown	fine		subangular	fair	6	maybe	
	IPq	Quadrant Formation	03N	03E	35	CCC		45.9631	-111.3268			63	12	Quartzitic sandstone: grayish white with light brown limonite specks throughout, weathers yellowish brown to greenish brown	fine		subangular	fair	7.5	maybe	
	IPq	Quadrant Formation	03N	03E	35	CCC		45.9631	-111.3268			64	14	Sandstone: yellowish-white, weathers yellowish gray	fine	very little calcareous cement, resistant	subangular to sub-rounded	fairly well	4.7	maybe	
	IPq	Quadrant Formation	03N	03E	35	CCC		45.9631	-111.3268			64	17	Quartzite: dense, finely crystalline, grayish white, weathers with yellowish brown stain	crystalline	very hard			12	no	
	IPq	Quadrant Formation	03N	03E	35	CCC		45.9631	-111.3268			64	20	Quartz sandstone		quartz grains	subangular	fairly well	2.5	maybe	
	Jme	Ellis Group (undifferentiated)	03N	03E	25		Intersection of sections 25, 26, 35, 36. (45.97668, -11.3072)	45.97668	-111.3072			68	2	Sandstone: weathers along 1-2" bedding planes, moderate yellowish brown	fine	slightly calcareous with much limonitic			11.5	no	
	Jme	Ellis Group (undifferentiated)	03N	03E	25		(45.97668, -11.3072)	45.97668	-111.3072			68	3	Sandstone: limonitic, fossiliferous, pale brown	fine	calcareous	subangular		6.3	no	

section Id	Unit Symbol	Measured Section Name	TWP	Rng	Sec	Qsec	Loc Notes	Lat (Apprx)	Long (Apprx)	method	Horizontl Datum	Page Num	Sub Unit Id	Description	Grain Size	Cementation	Roundness	Sorting	Thick Ft	Suit-ability?	Ref Id
	Kk	Kootenai Formation	03N	03E	36	N2	measured in the large dry gulley					71	1	Quartzitic sandstone: medium to thick bedded, limonite specks and fine black chert disseminated throughout ('salt and pepper')	fine		sub-angluar to rounded		25	no	
	Kk	Kootenai Formation	03N	03E	36	N2	measured in the large dry gulley					71	6	Sandstone: massive, resistant, thick bedded basal unit, has iron stains and brownish-black chert grains, strongly cross bedded, some conglomerate, pale red	medium				68	no	
	Mk	section of the Kibbey Formation	16N	17E	11	D		47.16224	-109.5228			42	1	Sandstone: some breccia at the top with this sandstone and a calcite matrix, grayish orange, weathers buff to moderate red	fine	calcareous			4.85	maybe	
	Mk	section of the Kibbey Formation	16N	17E	11	D		47.16224	-109.5228			42	2	Sandstone: massive beds, some units brecciated and re- with calcite, very pale orange and grayish orange	medium	calcareous			18	maybe	
	Mk	section of the Kibbey Formation	16N	17E	11	D		47.16224	-109.5228			43	3	Sandstone: thin bedded, grayish pink and grayish orange, some units stained a moderate red with iron oxide	fine to medium				18.4	maybe	
	Mk	section of the Kibbey Formation	16N	17E	11	D		47.16224	-109.5228			43	4	Sandstone: massive to moderately thin bedded, grayish pink and orange	fine to medium	calcareous			30	maybe	
	Mk	section of the Kibbey Formation	16N	17E	11	D		47.16224	-109.5228			43	5	Sandstone: interbedded with pinkish limestone (arenaceous), scattered exposure		not a ridge former			62.5	no	
	Mk	section of the Kibbey Formation	16N	17E	11	D		47.16224	-109.5228			43	6	Sandstone: massive, stained with iron oxide, ridge former, very pale orange and grayish orange,	fine	calcareous			1.4	maybe	
	Jsw	section of the Swift formation	17N	17E	36	C		47.18967	-109.5045			43	1	Sandstone: thin bedded to massive, ferruginous, not extremely glauconitic, yellowish gray to grayish ornage	fine to medium	calcareous			38.6	no	
	Jsw	section of the Swift formation	17N	17E	36	C		47.18967	-109.5045			43	2	Sandstone: massive beds, cross bedding and channeling, fossils, alternating yellow gray, clean and dark yellowish orange, limonitic	fine to medium	glauconitic			24	no	
	Jsw	section of the Swift formation	17N	17E	36	C		47.18967	-109.5045			43	4	Sandstone: thin bedded, glauconitic, thin shale partings, pale yellowish brown to light gray	medium	calcareous			19	no	
	Jsw	section of the Swift formation	17N	17E	36	C		47.18967	-109.5045			43	5	Sandstone: moderately conglomeratic, glauconitic, fossil fragments, orange brown	coarse	calcareous			3.7	no	
	Jsw	section of the Swift formation	17N	17E	36	C		47.18967	-109.5045			43	7	Sandstone: glauconitic, exhibits heavy cross bedding, channeling and graded bedding, light olive gray to grayish orange	fine to medium	calcareous			7.25	no	
	Jsw	section of the Swift formation	17N	17E	36	C		47.18967	-109.5045			43	8	Sandstone: nodular to angular siderite, and fossil fragments, light olive gray	coarse to conglomeritic	slightly calcareous and glaucontic			0.6	no	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			55	1	Sandstone: thin bedded, pale yellowish orange	fine	non-calcareous, loosely			20.6	yes	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			55	4	Sandstone: pale yellowish orange	medium to coarse	calcareous, loosely			19.1	yes	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			55	6	Sandstone: some breccia at the top with this sandstone and a calcite matrix, grayish orange, weathers buff to moderate red	medium	calcareous, loosely			11.2	yes	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			56	8	Sandstone: 'salt and pepper', massive, grayish orange, irong staining and concretions	medium	loosely			5.9	no	

sectionId	Unit Symbol	Measured Section Name	TWP	Rng	Sec	Qsec	Loc Notes	Lat (Apprx)	Long (Apprx)	method	Hrz ntl Datum	Page Num	Sub Unit Id	Description	Grain Size	Cementation	Roundness	Sorting	Thick Ft	Suit-ability?	Ref Id
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			56	10	Sandstone: thin bedded, very pale orange to reddish brown	fine to medium	calcareous, loosely			7.6	maybe	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			56	14	Sandstone: moderately thick bedded, 'salt and pepper', very light gray and grayish orange, loosely , cross bedded, thin conglomerate at base	fine to medium	calcareous, loosely			17.7	no	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			56	16	Sandstone: dark brown limonite concretions at top, very pale orange	fine	calcareous			3	maybe	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			56	18	Sandstone: pale yellowish orange	fine	slightly calcareous, loosely			0.75	maybe	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			56	21	Sandstone: 'salt and pepper', conglomerate at base, light reddish orange.	medium to coarse	non-calcareous, loosely			13.5	no	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			56	22	Sandstone: 'salt and pepper', limonitic, fossilized wood, conglomerate at base, dark yellowish orange	coarse	loosely			1.5	no	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			56	23	Sandstone: massive, limonitic, cross bedded with channels, dark yellowish orange	medium	calcareous, loosely			29.5	maybe	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			57	24	Sandstone: 'salt and pepper', pale yellowish brown	coarse	loosely, non-calcareous			4.25	no	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			57	25	Sandstone: 'salt and pepper', crossbedded with thin conglometate layer at base,loosely , light olive gray	medium	loosely, non-calcareous			2	no	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			57	26	Sandstone: 'salt and pepper', conglomerate and siderite common, dark yellowish orange to light olive gray	coarse	loosely, non-calcareous			1.25	no	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			57	27	Sandstone: 'salt and pepper', grayish orange	coarse	loosely, non-calcareous			5	no	
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			57	29	Sandstone: 'salt and pepper', grayish orange	coarse	loosely, non-calcareous			1	no	

sectionId	Unit Symbol	Measured Section Name	TWP	Rng	Sec	Qsec	Loc Notes	Lat (Apprx)	Long (Apprx)	method	ntl Datum	Page Num	Sub Unit Id	Description	Grain Size	Cementation	Roundness	Sorting	Thick Ft	Suit-ability?	Ref Id
	Kk	A section of the plant-bearing lower Cretaceous Kootenai Formation	17N	17E	33	C		47.18929	-109.5687			57	31	Sandstone: 'salt and pepper', heavily cross-bedded and locally conglomeratic, grayish orange	coarse	loosely , non-calcareous			56.1	no	

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EXHIBIT 3

Drilling Notification Draft Rule

February 10, 2015

(1) For the purposes of this section, "occupied dwelling" means a building used for a human dwelling.

(2) An applicant for a permit to drill a new well under ARM 36.22.601 must provide reasonable notice of the intent to file an application to all owners of record of an occupied dwelling within 1,320 feet of the proposed well.

(a) The notice must advise each owner that the application is eligible for administrative approval unless a demand for an opportunity to be heard is filed with the board within 14 days of an owner having received the notice.

(b) The applicant must file proof of the notice required by this section with its application to the Board.

(c) The 14 day requirement may be waived by the owner in writing.

(3) The staff of the board shall refer an application for permit to drill to the board for notice and public hearing if an owner of an occupied dwelling, as to any application for permit to drill for which they received notice, files a demand for an opportunity to be heard concerning the application in the form set forth in subsection 5.

(4) In those instances where such requests for a permit to drill have been the subject of notice and public hearing, the board shall, after such hearing, either:

(a) Enter its order granting such permit under such conditions as the board shall find proper and necessary; or

(b) Enter its order denying the application for the permit.

(5) A demand for opportunity to be heard concerning an application for permit to drill for which notice is required must:

(a) Be in writing; and

(b) Set forth the name, address, and telephone number of each party making the demand, and their ownership interest, if any, in the lands surrounding the drill site; and

(c) Set forth the specific reasons why the party requests a hearing regarding the issuance of the proposed drilling permit; and

(d) Be received by the board no later than fourteen (14) days after the date the notice is received by the owner. Service of such demand may be made on the board personally, by mail, or by FAX transmission; and

(e) Be simultaneously served upon the applicant for the permit by written copy mailed or FAX transmitted to the address or number set forth in the published notice. A certificate of such service must accompany the demand as filed with the board.

EXHIBIT 4

MONTANA BOARD OF OIL AND GAS CONSERVATION
FINANCIAL STATEMENT
As of 2/1/2016
Fiscal Year 2016: Percent of Year Elapsed - 59%

		Budget	Expends	Remaining	%
Regulatory	Personal Services	1,288,795	567,270	721,525	0.44
UIC	Personal Services	191,043	89,082	101,961	0.47
	Total Expends	1,479,838	656,352	823,486	0.44
Regulatory	Equipment & Assets	39,477	-	39,477	0.00
UIC	Equipment & Assets	17,073	-	17,073	0.00
	Total Expends	56,550	-	56,550	0.00
Regulatory	Contracted Services	175,279	61,523	113,756	0.35
	Supplies & Materials	48,500	20,137	28,363	0.42
	Communication	71,819	26,096	45,723	0.36
	Travel	38,000	16,157	21,843	0.43
	Rent	33,000	18,077	14,923	0.55
	Utilities	15,000	9,492	5,508	0.63
	Repair/Maintenance	15,620	10,508	5,112	0.67
	Other Expenses	20,000	8,043	11,957	0.40
	Total Operating Expenses	417,218	170,032	247,186	0.41
UIC	Contracted Services	14,976	4,914	10,062	0.33
	Supplies & Materials	12,561	2,083	10,478	0.17
	Communication	12,000	2,811	9,189	0.23
	Travel	9,213	1,965	7,248	0.21
	Rent	3,000	1,478	1,522	0.49
	Utilities	7,000	1,238	5,762	0.18
	Repair/Maintenance	9,000	1,639	7,361	0.18
	Other Expenses	13,876	1,387	12,489	0.10
	Total Operating Expenses	81,626	17,515	64,111	0.21
	Total Expends	498,844	187,547	311,297	0.38

	Budget	Expends	Remaining	%
Carryforward FY14				
Personal Services	20,331	-	20,331	0.00
Operating Expenses	30,497	-	30,497	0.00
Equipment & Assests	50,828	-	50,828	0.00
Total	101,656	-	101,656	0.00
Carryforward FY15				
Personal Services	40,249	-	40,249	0.00
Operating Expenses	80,497	-	80,497	0.00
Equipment & Assests	80,497	-	80,497	0.00
Total	201,243	-	201,243	0.00

Funding Breakout	Regulatory Budget	Regulatory Expends	UIC Budget	UIC Expends	2016 Total Budget	2016 Total Expends	%
State Special	1,745,490	737,302	289,742	106,597	2,035,232	843,899	0.41
Federal 2016 UIC (10-1-2015 to 9-30-2016)			109,000	25,868	109,000	25,868	0.24
Total	1,745,490	737,302	398,742	132,465	2,144,232	869,767	0.41

REVENUE INTO STATE SPECIAL REVENUE ACCOUNT as of 2/1/16

	FY 16	FY 15
Oil & Gas Production Tax	$ 573,666	$ 1,340,402
*Oil Production Tax	39,260	101,210
*Gas Production Tax	534,406	1,239,192
Drilling Permit Fees	8,350	39,925
UIC Permit Fees	226,600	231,890
Interest on Investments	3,718	5,616
Copies of Documents	1,011	4,448
Miscellaneous Reimbursements	24,500	13,000
TOTAL	$ 837,845	$ 2,975,683

REVENUE INTO DAMAGE MITIGATION ACCOUNT as of 2/1/16

	FY 16	FY 15
RIT Investment Earnings	$ 213,929	$ -
Bond Forfeitures:		45,128
Cavalier Petroleum	15,000	
Coastal Petroleum Company	50,000	
Interest on Investments	565	588
TOTAL	$ 279,494	$ 45,716

INVESTMENT ACCOUNT BALANCES as of 2/1/16

Regulatory Account	$ 2,998,913
Damage Mitigation Account	$ 749,962

REVENUE INTO GENERAL FUND FROM FINES as of 2/1/16

		FY 16
BENSUN ENERGY	7/17/2015	$ 120
CCG LLC / GRYNBERG, JACK	7/17/2015	70
HOFLAND JAMES D. / J. H OIL COMPANY	7/17/2015	210
ALTURAS ENERGY LLC	7/24/2015	1,000
GRAY WOLF PRODUCTION COMPANY INC	7/24/2015	100
ROARK, DANIEL/TINA / DANIELSON, PATRICIA	7/31/2015	140
STATOIL OIL AND GAS LP	7/31/2015	70
SONKAR INC	8/5/2015	70
RIMROCK COLONY INC.	8/14/2015	130
KLANIKA KENNETH / STATOIL OIL AND GAS LP	8/14/2015	70
MONTANA OIL FIELD ADQUISITION	8/21/2015	360
J BURNS BROWN OPERATING COMPANY	9/4/2015	400
MONTANA LAND AND MINERAL COMPANY	10/2/2015	60
BALKO INC	10/2/2015	530
WINDY BUTTE RECLAMATION FACILITY LLC	10/30/2015	120
HINTO ENERGY / HERICK, GARY J.	11/13/2015	1,360
HINTO ENERGY / HERICK, GARY J.	12/11/2015	20
KYKUIT RESOURCES LLC / OSAIR INC	12/14/2015	1,520
DENBURY ONSHORE LLC	1/11/2016	3,000
TOTAL		9,350

GRANT BALANCES - 2/1/16

Name	Authorized Amt*	Expended	Balance	Expiration Date
2011Southern - TankBattery2 RIT 12-8723	$ 204,951	$ 166,548	$ 38,403	9/30/2016
2011 Northern/Eastern RIT 13-8753	332,642	203,004	129,638	9/30/2016
TOTAL	$ 537,593	$ 369,552	$ 168,041	

* includes match requirement for grant

CONTRACT BALANCES - 2/1/16

Name	Authorized Amt	Expended	Balance	Status	Expiration Date
MT Tech - Elm Coulee EOR Study (MOU 127220)	$ 863,905	$ 492,909	$ 370,996	Under Contract	12/31/2017
MT Tech - Survey of Native Proppant (SNaP)	383,101	369,721	13,380	Under Contract	12/31/2015
Agency Legal Services (ALS - Legal) (ALS-2016)	25,000	22,771	2,229	Under Contract	6/30/2016
Automated Maintenance Services, Inc. (OG-AMS-149)	24,197	12,143	12,054	Under Contract	6/30/2016
Central Avenue Mall FY '16 (9/1/15 - 8/31/16)	400	400	-	Completed	8/31/2016
Central Avenue Mall FY '17 (9/1/16 - 8/31/17)	400	-	400	Under Contract	8/31/2017
HydroSolutions - EPA Primacy Class VI Injection (DNR12-2558T)	57,156	56,392	764	Under Contract	5/31/2016
TOTAL	$ 1,354,159	$ 954,337	$ 399,823		

Agency Legal Services Expenditures in FY16

Case	Amt Spent
BOGC Duties	$ 19,969
Hekkel	532
CCRC	616
Omimex	1,050
Ostby	191
Malsam	413
Total	$ 22,771

Privilege and License Tax

Oil price during the past biennium averaged $74/barrel (EIA First Purchaser Price) and quarterly expenditures generally exceeded income at the current tax rate of 0.0009 or 30% of the maximum allowable rate. Current oil price - $20/barrel (North Dakota, NDIC weekly report).

A decrease in oil price from $80/barrel to $20/barrel would require a four-fold increase in the Privilege & License Tax to maintain income levels. (0.0009 X 4 = 0.0036, which is above the statutory cap of 0.003.)

With production decline, $98/barrel oil price approximates FY 17 Q4 budget at the current tax rate of 0.09% (30% of 0.3 of 1%). Decline may increase if wells are shut-in.

At $20/barrel, Budgeted FY 17 Q4 expenditures require a tax rate in excess of the statutory cap of 0.3 of 1%; the maximum allowable rate would only allow a quarterly expenditure of approximately $400,000, compared the budgeted expenditure of $525,000.

Tax Rate is very price sensitive:

Oil Price	Decimal Rate	
$20	0.00386	To match FY 17 Q4 Budget ($500,000)
$25	0.00318	
$30	0.00271	
$40	0.00216	
$50	0.00176	

An additional $1,555,056 will be removed from the reserve account during this biennium due to legislative transfers (Sage Grouse Program, Bureau of Mines, St. Mary's irrigation). This is amount is equivalent to 3 quarters of normal expenditure, and withdrawal will bring the reserve account balance to low levels at or before the end of the biennium under any reasonable price forecast.

Tax receipts are delayed approximately 2 quarters. CY 15 Q3 (July-September) production taxes were received during CY 16 1Q (January-March).

- **To have an increased tax rate effective in tax receipts during CY 17 Q2, or April – June 2017, the modified rate would have to be applied to production that occurs during CY 16 Q4 (October – December 2016); an October 1 effective date would likely require rulemaking to begin no later than April 1, 2016.**

15-36-304, MCA

(c) The board of oil and gas conservation shall give the department at least 90 days' notice of any change in the rate adopted by the board. Any rate change of the tax to fund the oil and gas natural resource distribution account is effective at the same time that the board of oil and gas conservation rate is effective.

Recommendation

36.22.1242 REPORTS BY PRODUCERS – TAX REPORT – TAX RATE

(1) Each owner or operator of an oil or gas well or any other well (except an injection well reported on Form No. 5) shall file or cause to be filed with the board on or before the last day of each month following the month being reported on Form No. 6 containing all information required by said form and accurately reporting the status of each well thereon as of the last day of the month reported.

(2) The privilege and license tax on each barrel of crude petroleum and each 10,000 cubic feet of natural gas produced, saved, and marketed, or stored within the state or exported therefrom shall be ~~30.00~~100.00 percent ~~(0.9/10 of 1%)~~ of the rate authorized in 82-11-131 , MCA, (3/10 of 1%) of the market value thereof. This rule is effective on all crude petroleum and natural gas produced on and after October 1, ~~2006~~2016.

History: 82-11-111, MCA; IMP, 82-11-123, 82-11-131, 82-11-133, MCA; Eff. 12/31/72; AMD, 1982 MAR p. 1398, Eff. 7/16/82; AMD, 1982 MAR p. 2149, Eff. 12/17/82; AMD, 1983 MAR p. 1195, Eff. 8/26/83; AMD, 1986 MAR p. 1384, Eff. 8/15/86; AMD, 1992 MAR p. 654, Eff. 4/1/92; AMD, 1993 MAR p. 152, Eff. 7/1/94; AMD, 1995 MAR p. 1055, Eff. 6/16/95; AMD, 2001 MAR p. 2243, Eff. 11/9/01; AMD, 2005 MAR p. 1045, Eff. 7/1/05; AMD, 2006 MAR p. 2110, Eff. 9/8/06.

2/10/2016

					Income			Expenditures												
Month	Months	CY	FY	Beginning Balance	P&L	UIC	Misc	Budgeted	Expended	Transfers	Misc	End Balance	Prod Receipt	Oil Prod	Gas Prod	Oil$	Gas$	Tax	Oil Value	Gas Value
													(tax effective)							
0	Oct-Dec	4Q-2014	FY 15 Q2																	
1	Jan-Mar	1Q-2015	FY 15 Q3							1,350,000.00										
2	Apr-Jun	2Q-2015	FY 15 Q4							-			x	7,810,865	12,179,729					
3	Jul-Sep	3Q-2015	FY 16 Q1	3,990,170.51		-	10,764.52	508,808.00	380,681.51	162,357.22	69,474.50	3,388,421.80		7,601,245	11,871,092	$37.42	$2.08	0.0009	$255,989.57	$22,259.96
4	Oct-Dec	4Q-2015	FY 16 Q2	3,388,421.80	331,693.99	31,400.00	30,558.27	508,808.00	362,773.02	168,621.45	91,403.29	3,159,276.30		7,298,987	12,106,945	$47.46	$1.83	0.0009	$311,792.35	$19,901.64
5	Jan-Mar	1Q-2016	FY 16 Q3	3,159,276.30	241,969.82	195,200.00	2,651.24	508,808.00	400,000.00	100,446.28	138.00	3,098,513.08	CY 3Q-2015	6,927,288	12,117,577	$35.71	$1.77	0.0009	$222,612.23	$19,357.59
6	Apr-Jun	2Q-2016	FY 16 Q4	3,098,513.08	$202,952.63		-	508,808.00	508,808.00	609,319.05	-	2,183,338.66	CY 4Q-2015	6,593,334	11,926,311	$31.00	$1.77	0.0009	$183,954.02	$18,998.61
7	Jul-Sep	3Q-2016	FY 17 Q1	2,183,338.66	$131,240.65		-	525,255.75	525,255.75	945,736.00	-	843,587.56	CY 1Q-2016	6,252,329	11,738,064	$20.00	$1.77	0.0009	$112,541.91	$18,698.74
8	Oct-Dec	4Q-2016	FY 17 Q2	843,587.56	$125,739.72	31,400.00	-	525,255.75	525,255.75	-	-	475,471.54	CY 2Q-2016	5,963,118	11,552,789	$20.00	$1.77	0.0009	$107,336.13	$18,403.59
9	Jan-Mar	1Q-2017	FY 17 Q3	475,471.54	$120,926.75	195,200.00	-	525,255.75	525,255.75	-	-	266,342.54	CY 3Q-2016	5,711,869	11,370,438	$20.00	$1.77	0.0009	$102,813.64	$18,113.11
10	Apr-Jun	2Q-2017	FY 17 Q4	266,342.54	$388,845.59		-	525,255.75	525,255.75	-	-	129,932.37	CY 4Q-2016	5,490,359	11,190,966	$20.00	$1.77	0.0030	$329,421.56	$59,424.03
11	Jul-Sep	3Q-2017	FY 18 Q1	129,932.37	$376,049.41		-	525,255.75	525,255.75	-	-	(19,273.97)	CY 1Q-2017	5,292,722	11,014,328	$20.00	$1.77	0.0030	$317,563.33	$58,486.08
12	Oct-Dec	4Q-2017	FY 18 Q2	(19,273.97)	$364,440.94	31,400.00	-	525,255.75	525,255.75	-	-	(148,688.78)	CY 2Q-2017	5,114,633	10,840,477	$20.00	$1.77	0.0030	$306,878.00	$57,562.93
														4,952,820	10,669,371	$20.00	$1.77	0.0030		
										3,336,480.00				4,804,751	10,500,966	$20.00	$1.77	0.0030		
														4,668,427	10,335,219	$20.00	$1.77	0.0030		
														4,542,249	10,172,089	$20.00	$1.77	0.0030		

$20	0.00386	To match FY 17 Q4 Budget ($500,000)
$25	0.00318	
$30	0.00271	
$40	0.00216	
$50	0.00176