

## High-Calcium Limestone GIS Layer

This GIS layer displays mapped geologic units having high-calcium limestone resource potential in Utah. High-calcium limestone typically contains a minimum of about 95%  $\text{CaCO}_3$  and is used for a variety of chemical applications. Several limestone-bearing geologic units in Utah have potential for high-calcium limestone. Where possible, we used the most recent GIS data from 1:100,000-scale geologic mapping to build this layer. Where detailed mapping was unavailable, we used the 1:500,000-scale geologic map of Utah.

Typically, only specific zones within a geologic formation contain high-calcium limestone, so the entire mapped exposure is not always representative of the resource. Each polygon within the high-calcium limestone layer has the following associated attributes: geologic unit name, unit age, resource potential ranking, and geologic map reference.

All of the geologic units in the layer are assumed to have some resource potential for high-calcium limestone based on available data. We assigned a **“high”** or **“moderate”** resource potential ranking to geologic units in areas that have the most substantive data to suggest presence of high-calcium limestone resources. Our assigned resource potential was primarily based on past production, available analytical data, and unit descriptions from the source map. Positive elements of geologic unit descriptions typically include thick or massive bedding. Indications of chert or other siliceous material, thin bedding, or recessiveness often suggest that limestone may not have high-calcium potential. Definition of areas that were given a similar ranking was somewhat subjective, but typically was confined to individual mountain ranges; spatial distribution of analytical data was also considered. The general guidelines we used to assign potential are described below.

Typically, we assigned a **“high”** resource potential to limestone-bearing geologic units in areas where the unit has been a significant source of produced high-calcium limestone, extensive analytical data showing high  $\text{CaCO}_3$  content are available (typically more than 15 samples), or a combination of some production and some analytical data suggest potential.

**“Moderate”** resource potential was assigned to geologic units in areas where the unit has been a more minor source of produced high-calcium limestone, some analytical data show high  $\text{CaCO}_3$  content (typically five or more samples) and a positive description is present, or a combination of limited production and limited analytical data.

We assigned an **“undetermined”** resource potential to units where some data suggest potential, but the data are limited. These include limestone-bearing units in areas where only a few analytical data indicate potential, units that show potential elsewhere (based on analytical or production data) but limited or no data are available in the area, or units that have a positive description in the area but no additional supporting data. We also typically assigned an **“undetermined”** resource potential when only 1:500,000-scale mapping was available.

This is not an exhaustive dataset. Several limestone-bearing geologic units in Utah were not selected for this layer. These units may possess high-calcium limestone but existing data or general lack of data led us to exclude them from this dataset.

**NOTE:** Our determinations of high-calcium limestone resource potential DO NOT imply a determination of locatability for claim-staking purposes.

Data used to evaluate high-calcium limestone for this layer came from several published and unpublished sources.

**Useful references:**

Tripp, B.T., 2005, High-calcium limestone resources of Utah: Utah Geological Survey Special Study 116, 23 p., 7 appendices.

Tripp, B.T., Kirschbaum, M.J., Vanden Berg, M.D., Rupke, A.L., Gwynn, J.W., Boden, T., and Blackett, R.E., 2006, Chemical analyses of selected limestone, silica, and dolomite samples collected in northwest Utah, *in* Harty, K.M., and Tabet, D.E., editors, Geology of northwest Utah: Utah Geological Association Publication 34, CD-ROM, papers individually paginated, 16 p., 6 appendices.

## High-Magnesium Dolomite GIS Layer

This GIS layer displays mapped geologic units having high-magnesium or high-purity dolomite resource potential in Utah. High-magnesium dolomite typically contains a minimum of about 42%  $\text{MgCO}_3$  and is used for a variety of chemical applications. Several dolomite-bearing geologic units in Utah have potential for high-magnesium dolomite. Where possible, we used the most recent GIS data from 1:100,000-scale geologic mapping to build this layer. Where detailed mapping was unavailable, we used the 1:500,000-scale geologic map of Utah.

Typically, only specific zones within a geologic formation are high-magnesium dolomite, so the entire mapped exposure is not always representative of the resource. Each polygon within the high-magnesium dolomite has the following associated attributes: geologic unit name, unit age, resource potential ranking, and geologic map reference.

All of the geologic units in the layer are assumed to have some resource potential for high-magnesium dolomite based on available data. We assigned a “**high**” or “**moderate**” resource potential ranking to geologic units in areas that have the most substantive data to suggest presence of high-magnesium dolomite resources. Our assigned resource potential was primarily based on past production, analytical data, and unit descriptions from the source map. The general guidelines we used to assign potential are described below. Positive elements of geologic unit descriptions typically include thick or massive bedding. Indications of chert or other siliceous material, thin bedding, or recessiveness often suggest that dolomite may not have high-magnesium potential. Definition of areas that were given a similar ranking was somewhat subjective, but typically was confined to individual mountain ranges; spatial distribution of analytical data was also considered.

Typically, we assigned a “**high**” resource potential to dolomite-bearing geologic units in areas where the unit has been a significant source of produced high-magnesium dolomite, extensive analytical data showing high  $\text{MgCO}_3$  content are available (typically more than 15 samples), or a combination of some production and some analytical data suggest potential.

“**Moderate**” resource potential was assigned to geologic units in areas where the unit has been a more minor source of produced high-magnesium dolomite, some analytical data show high  $\text{MgCO}_3$  content (typically five or more samples) and a positive description is present, or a combination of limited production and limited analytical data.

We assigned an “**undetermined**” resource potential to units where some data suggest potential, but the data are limited. These include dolomite-bearing units in areas where only a few analytical data indicate potential, units that show potential elsewhere (based on analytical or production data) but limited or no data are available in the area, or units that have a positive description but no additional supporting data. We also typically assigned an “**undetermined**” resource potential when only 1:500,000-scale mapping was available.

This is not an exhaustive dataset. Several dolomite-bearing geologic units in Utah were not selected for this layer. These units may possess high-magnesium dolomite but existing data or general lack of data led us to exclude them from this dataset.

**NOTE:** Our determinations of high-magnesium dolomite resource potential DO NOT imply a determination of locatability for claim-staking purposes.

Data used to evaluate high-magnesium dolomite for this layer came from several published and unpublished sources.

**Useful references:**

Morris, H.T., 1964, Limestone and dolomite, *in* Hilpert, L.S., editor, Mineral and water resources of Utah: Utah Geological and Mineralogical Survey Bulletin 73, p. 188-194.

Tripp, B.T., Kirschbaum, M.J., Vanden Berg, M.D., Rupke, A.L., Gwynn, J.W., Boden, T., and Blackett, R.E., 2006, Chemical analyses of selected limestone, silica, and dolomite samples collected in northwest Utah, *in* Harty, K.M., and Tabet, D.E., editors, Geology of northwest Utah: Utah Geological Association Publication 34, CD-ROM, papers individually paginated, 16 p., 6 appendices.

Williams, J.S., 1958, Geologic atlas of Utah—Cache County: Utah Geological and Mineralogical Survey Bulletin 64, 98 p.

## Gypsum GIS Layer

This GIS layer displays mapped geologic units having gypsum resource potential in Utah. Gypsum is used for many purposes including several construction and agricultural applications. Required purity of a gypsum deposit depends on the end use, but deposits often contain 10% or more of impurities. Utah hosts several gypsum-bearing geologic units, including some that are quite pure. Where possible, we used the most recent GIS data from 1:100,000-scale geologic mapping to build this layer. Where detailed mapping was unavailable, we used the 1:500,000-scale geologic map of Utah. Typically, only specific zones within a geologic formation contain gypsum, so the entire mapped exposure of a unit does not imply that it is entirely gypsum. Each polygon within the gypsum layer has the following associated attributes: geologic unit name, unit age, resource potential ranking, and geologic map reference. Gypsum is typically mined at depths of less than 600 feet, so we did not include subsurface gypsum resources, such as those of the Paradox Basin.

All of the geologic units in the layer are assumed to have some resource potential for gypsum based on available data. Our rankings for resource areas are primarily based on production data and gypsum bed thickness data. We assigned a **“high”** resource potential ranking to geologic units in areas where that unit has been a source of substantial gypsum production. A **“moderate”** resource potential was given to units in areas where limited production has occurred or multiple data points suggest substantial gypsum beds (typically greater than 10 feet thick). An **“undetermined”** resource potential ranking was assigned to units that are known to have gypsum beds, but additional, detailed data are limited.

This is not an exhaustive dataset. Other geologic units in Utah may have resource potential for gypsum but were not selected for this layer due to lack of substantial data.

**NOTE:** Our determinations of gypsum resource potential DO NOT imply a determination of locatability for claim-staking purposes.

Data used to evaluate gypsum for this layer came from published and unpublished sources.

### Useful references:

Rupke, A.L., and Boden, T., 2013, Gypsum resources of the San Rafael Swell, *in* Morris, T.H., and Ressetar, R., editors, The San Rafael Swell and Henry Mountains basin—geologic centerpiece of Utah: Utah Geological Association Publication 42, p. 445-460.

Willis, G.C., 2006, Salt and gypsum of the Arapien Shale—the central Utah evaporite mineral industry, Utah, *in* Harty, K.M., and Tabet, D.E., editors, Geology of northwest Utah: Utah Geological Association Publication 34, p. 604-643.

Withington, C.F., 1964, Gypsum and anhydrite, *in* Hilpert, L.S., editor, Mineral and water resources of Utah: Utah Geological and Mineralogical Survey Bulletin 73, p. 177-185.

## Bentonite GIS Layer

This GIS layer displays mapped geologic units having bentonite resource potential in Utah. Bentonite is used in drilling mud, as an absorbent, as a binder for foundry sand and iron ore pelletizing, as an environmental sealer, and for a variety of other applications. Bentonite generally consists of smectite clays and for industrial use is generally classified as sodium (Na) or calcium (Ca) bentonite depending on the dominant composition of the clay. Na bentonites have more swelling capability than Ca bentonites, which can be important for a variety of applications. Several geologic units in Utah contain bentonite. Where possible, we used the most recent GIS data from 1:100,000-scale geologic mapping to build this layer. Where detailed mapping was unavailable, we used the 1:500,000-scale geologic map of Utah. Typically, only specific zones within a geologic formation contain bentonite, so the entire mapped exposure of a unit does not imply resource potential. Each polygon within the bentonite layer has the following associated attributes: geologic unit name, unit age, resource potential, and geologic map reference.

All of the geologic units in the layer are assumed to have some resource potential for bentonite based on available data. Limited data are available on bentonite resource potential in Utah and our resource potential rankings were primarily based on past production. We assigned a “**high**” resource potential ranking to exposures of bentonite-bearing units in areas that have had significant past production. We assigned a “**moderate**” resource potential to areas where lesser bentonite production has occurred. An “**undetermined**” resource potential ranking was assigned to exposures of geologic units that are known to have bentonitic layers, but additional supporting data are limited or non-existent.

This is not an exhaustive dataset. Other geologic units in Utah may have resource potential for bentonite but were not selected for this layer due to lack of substantial data.

**NOTE:** Our determinations of bentonite resource potential DO NOT imply a determination of locatability for claim-staking purposes.

Data used to evaluate bentonite for this layer came from published and unpublished sources.

### Useful references:

Hall, R.B., editor, 1985, Clays and clay minerals, western Colorado and eastern and central Utah: AIPEA 1985 International Clay Conference Field Trip Guidebook, 76 p.

Keller, W.D., 1962, Clay minerals in the Morrison Formation of the Colorado Plateau: U.S. Geological Survey Bulletin 1150, 90 p.

Schultz, L.G., 1963, Clay minerals in Triassic rocks of the Colorado Plateau: U.S. Geological Survey Bulletin 1147-C, 71 p.

## Silica GIS Layer

This GIS layer displays mapped geologic units having silica resource potential in Utah. Possible geologic sources for silica in Utah include sand, sandstone, and quartzite. For the purpose of this layer, the term silica is used broadly and includes industrial sand, silica sand, etc. Silica is used for a variety of applications and sources need to be relatively pure; potential resources should generally be a minimum of about 95% SiO<sub>2</sub>. Several geologic units in Utah have potential for silica, and, where possible, we used the most recent GIS data from 1:100,000-scale geologic mapping to build this layer. Where detailed mapping was unavailable, we used the 1:500,000-scale geologic map of Utah.

In some cases, only specific intervals within a geologic formation may contain relatively pure silica zones, so the entire mapped exposure is not always representative of the resource. Each polygon within the silica layer has the following associated attributes: geologic unit name, unit age, resource potential ranking, and geologic map reference.

All of the geologic units in the layer are assumed to have some resource potential for silica based on available data. We assigned a **“high”** or **“moderate”** resource potential ranking to geologic units in areas that have the most substantive data to suggest presence of silica resources. Our assigned resource potential was primarily based on past production, available analytical data, and other published or unpublished information. Definition of areas that were given a similar ranking was somewhat subjective, but typically was confined to individual mountain ranges; spatial distribution of analytical data was also considered. The general guidelines we used to assign potential are described below.

We assigned a **“high”** resource potential to most of the Ordovician Eureka Quartzite because it is a known high-purity silica source. We also assigned a **“high”** ranking to a few other units in areas where substantial production occurred or relatively abundant data and past exploration activity indicate resource potential.

**“Moderate”** resource potential was assigned to geologic units in areas where the unit has been a minor source of produced silica and/or some analytical data show high SiO<sub>2</sub> content (typically four or more samples in an area).

We assigned an **“undetermined”** resource potential to units where some data or information suggest potential, but the data are limited. These include silica-bearing units in areas where only limited analytical data indicate potential, units that show potential elsewhere (based on analytical or production data) but limited or no data are available in the area, or units that have a positive description in the area but no additional supporting data. We also typically assigned an **“undetermined”** resource potential when only 1:500,000-scale mapping was available.

This is not an exhaustive dataset. Several silica-bearing geologic units in Utah were not selected for this layer. These units may possess a silica resource but existing data or general lack of data led us to exclude them from this dataset.

**NOTE:** Our determinations of silica resource potential DO NOT imply a determination of locatability for claim-staking purposes.

Data used to evaluate silica resource potential for this layer came from several published and unpublished sources.

### Useful references:

Ketner, K.B., 1964, Silica, *in* Hilpert, L.S., editor, Mineral and water resources of Utah: Utah Geological and Mineralogical Survey Bulletin 73, p. 218–222.

McBride, E.F., 2012, Petrology of the Eureka Quartzite (Middle and Late Ordovician), Utah and Nevada, USA: *Rocky Mountain Geology*, v. 47, no. 2, p. 101–131.

Rupke, A., and Boden, T., 2013, Frac sand potential on selected SITLA lands: Online, <https://trustlands.utah.gov/wp-content/uploads/2014/01/Frac-Sand-Potential-on-Selected-SITLA-Lands.pdf>.

Tripp, B.T., Kirschbaum, M.J., Vanden Berg, M.D., Rupke, A.L., Gwynn, J.W., Boden, T., and Blackett, R.E., 2006, Chemical analyses of selected limestone, silica, and dolomite samples collected in northwest Utah, *in* Harty, K.M., and Tabet, D.E., editors, *Geology of northwest Utah*: Utah Geological Association Publication 34, CD-ROM, papers individually paginated, 16 p., 6 appendices.



## Phosphate GIS Layer

This GIS layer displays mapped geologic units having phosphate resource potential in Utah. In the United States, phosphate-bearing rocks or “phosphate rock” are primarily used to manufacture fertilizers. Phosphate resource potential in Utah is found within the Meade Peak Member of the Permian Phosphoria Formation. The Meade Peak Member commonly occurs as a tongue within the Permian Park City Formation, and, depending on the map area, the Meade Peak Member is mapped separately or is undivided from adjacent formations and members. This layer generally includes the mapped exposures of the Park City Formation as well as other members of the Phosphoria Formation. In most cases, we used the recent GIS data from 1:100,000-scale geologic mapping to build this layer. In a few areas, we used more detailed mapping. Subsurface phosphate resources are not delineated in this layer.

In most cases, only a specific interval (or intervals) within the geologic formation contains significant phosphate, so the entire mapped exposures are not necessarily representative of the resource. Each polygon feature within the layer has the following associated attributes: geologic unit name, unit age, resource potential ranking, and geologic map reference.

We assigned a “**high**” or “**moderate**” resource potential ranking to areas that have the most substantive data to suggest presence of economic phosphate resources. Our assigned resource potential was primarily based on past production and available analytical data.

We assigned a “**high**” resource potential to the current and past producing areas of the southeast Uinta Mountains and the Crawford Mountains. Both areas also have supporting analytical data.

A “**moderate**” resource potential was assigned to areas where analytical data indicate that a minimum 5-foot section of phosphate rock has a minimum  $P_2O_5$  content of 20%. The distance that we extended our resource assignment along strike was subjective.

We assigned an “**undetermined**” resource potential to all other mapped areas of the Phosphoria (or Park City Formation), including areas where available analytical data show lower quality than those areas deemed as “moderate.”

**NOTE:** Our assignments of phosphate resource potential DO NOT imply eligibility for lease.

### Useful references:

Cheney, T.M., 1957, Phosphate in Utah—An analysis of the stratigraphy of the Park City and Phosphoria Formations, Utah—a preliminary report: Utah Geological and Mineralogical Survey Bulletin 59, 54 p.

Doelling, H.H., editor, 1980, Phosphate in Utah: Utah Geological and Mineralogical Survey Circular 66, 32 p.

Williams, J.S., 1939, Phosphate in Utah: Utah Agricultural Experiment Station Bulletin 290, 44 p.

Williams, J.S., and Hanson, A.M., 1942, Phosphate reserves of Utah: Utah Agricultural Experiment Station Bulletin 304, 24 p.

## Potash GIS Layers

These GIS layers display areas having potash resource potential in Utah. For these layers, the term potash refers to various potash commodities, including potassium chloride and potassium sulfate, that could potentially be produced from these areas. Geologic sources for potash in Utah include brines, evaporites, and alunite. Two layers, a polygon and a point layer, are used to display potential. The polygon layer is used to represent the extents of potential brine and evaporite resources, and the point layer is used to show the locations of potential alunite resources. Various sources were used to define the potential resource areas in this layer. For instance, the potential resource area of the Great Salt Lake Desert was modified from mud and salt flat areas defined by the Utah Geological Survey's *Digital Geologic Map of Utah* (M-179DM) by Hintze and others (2000) and the Paradox Basin potash zone is from Massoth (2012). The location of alunite occurrences is from the Utah Geological Survey's Utah Mineral Occurrence System (UMOS) database. Where appropriate, source information is included within the layers.

Each polygon or point feature within the layer has the following associated attributes: name, deposit type, resource potential ranking, reference, and comment.

All displayed areas are assumed to have some resource potential for potash based on available data; however, variation exists within any given displayed polygons. We assigned a “**high**” or “**moderate**” resource potential ranking to areas that have the most substantive data to suggest presence of potash resources. Our assigned resource potential was primarily based on past production, available resource data, and other published or unpublished information.

We assigned a “**high**” resource potential to potash producing areas or areas that have large defined resources, such as Great Salt Lake, Sevier Lake, the Bonneville Salt Flats, part of the Paradox Basin, and Blawn Mountain.

“**Moderate**” resource potential was assigned to Pilot Valley, an area that has been explored in the past, but where a limited resource appears to be present.

We assigned an “**undetermined**” resource potential to areas where limited data are available to determine resource potential.

**NOTE:** Our assignments of potash resource potential DO NOT imply a determination of locatability or eligibility for lease.

### Useful references:

Hall, R.B., 1978, World nonbauxite aluminum resources—Alunite: U.S. Geological Survey Professional Paper 1076-A, 35 p.

Massoth, T.W., 2012, Well database and maps of salt cycles and potash zones of the Paradox Basin, Utah: Utah Geological Survey Open-File Report 600, 19 p., 22 plates, 1 appendix.

Mills, S.E., and Rupke, A., 2020, Critical minerals of Utah: Utah Geological Survey Circular 129, 49 p.