Independent Gilsonite Vein, Uintah County

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UTAH GEOSITES
2019

UTAH GEOLOGICAL ASSOCIATION PUBLICATION 48

M. Milligan, R.F. Biek, P. Inkenbrandt, and P. Nielsen, editors

Cover Image: *Historical open-cut mining on the southeast end of the Cowboy vein. View to the southeast.*

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Utah Geosites showcases some of Utah's spectacular geology, both little-known localities and sites seen by visitors to Utah's many national and state parks and monuments. The geosites reflect the interests of the many volunteers who wrote to share some of their favorite geologic sites. The list is eclectic and far from complete, and we hope that additional geosites will be added in the coming years. The Utah Geological Survey also maintains a list of geosites https://geology.utah.gov/apps/geosights/index.htm.

We thank the many authors for their geosite contributions, Utah Geological Association members who make annual UGA publications possible, and the American Association of Petroleum Geologists—Rocky Mountain Section Foundation for a generous grant for desktop publishing of these geosite papers.

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PRESIDENTS MESSAGE

I have had the pleasure of working with many different geologists from all around the world. As I have traveled around Utah for work and pleasure, many times I have observed vehicles parked alongside the road with many people climbing around an outcrop or walking up a trail in a canyon. Whether these people are from Utah or from another state or country, they all are quick to mention to me how wonderful our geology is here in Utah.

Utah is at the junction of several different geological provinces. We have the Basin and Range to the west and the Central Utah Hingeline and Thrust Belt down the middle. The Uinta Mountains have outcrops of some of the oldest sedimentary rock in Utah. Utah also has its share of young cinder cones and basaltic lava flows, and ancient laccoliths, stratovolcanoes, and plutonic rocks. The general public comes to Utah to experience our wonderful scenic geology throughout our state and national parks. Driving between our national and state parks is a breathtaking experience.

The "Utah Geosites" has been a great undertaking by many people. I wanted to involve as many people as we could in preparing this guidebook. We have had great response from authors that visit or work here in the state. Several authors have more than one site that they consider unique and want to share with the rest of us. I wanted to make the guidebook usable by geologists wanting to see outcrops and to the informed general public. The articles are well written and the editorial work on this guidebook has been top quality.

I would like to personally thank Mark Milligan, Bob Biek, and Paul Inkenbrandt for their editorial work on this guidebook. This guidebook could not have happened without their support. I would like to thank Jenny Erickson for doing the great desktop publishing and the many authors and reviewers that helped prepare the articles. Your work has been outstanding and will certainly showcase the many great places and geology of Utah. Last, but not least, Thank you to the American Association of Petroleum Geologists, Rocky Mountain Section Foundation for their financial support for this publication.

Guidebook 48 will hopefully be a dynamic document with the potential to add additional "geosites" in the future. I hope more authors will volunteer articles on their favorite sites. I would like to fill the map with locations so that a person or family looking at the map or articles will see a great location to read about and visit. Enjoy Guidebook 48 and enjoy the geology of Utah.

Peter J. Nielsen
2019 UGA President

INTRODUCTION

The Uinta Basin of northeastern Utah (figure 1) contains a wide variety of hydrocarbon resources including vast accumulations of crude oil and natural gas deposits, one of the largest oil shale resources in the world, and the largest tar sand deposit in the United States. In addition, unique solid hydrocarbons, including gilsonite, wurtzilite, tabbyite, and ozokerite, have a long and colorful history of exploration and/or production in the region. The most abundant of these, gilsonite, occurs in distinctive swarms of subparallel, northwest-trending veins. The lateral continuity of the veins is impressive, with relatively long, straight ribbons stretching across the hills of the eastern Uinta Basin. The veins are also vertically continuous, extending hundreds to more than 3000 feet (900 m) below the ground, commonly having only small variations in width.

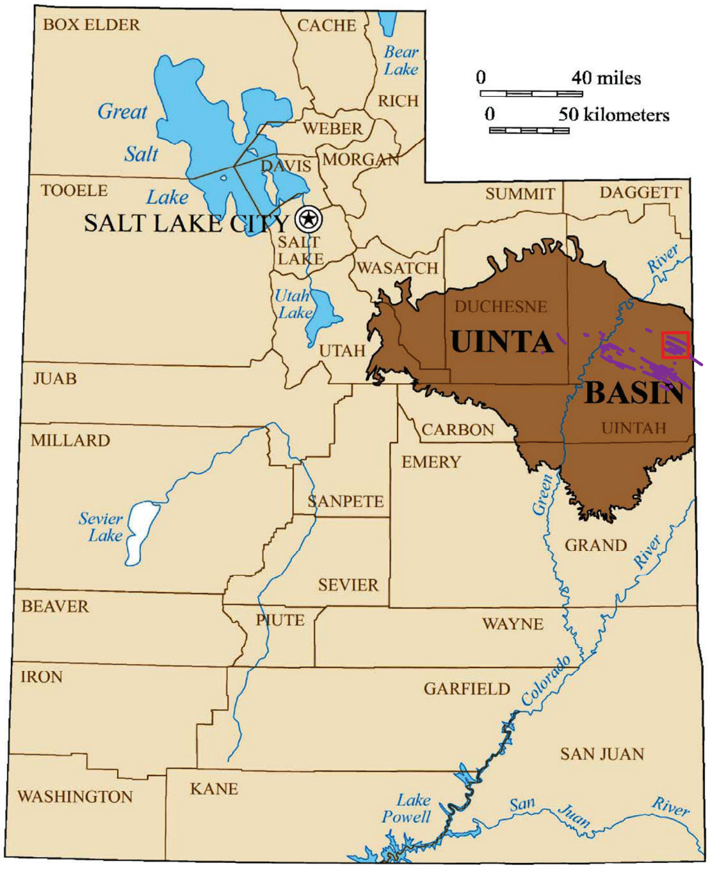


Figure 1. The eastern Uinta Basin in northeast Utah is host to numerous gilsonite veins (purple lines). The red box is the area of focus and is shown on figure 3.

The Uinta Basin contains the world's largest deposit of gilsonite and is the only place in the world where this unique resource is economically produced. Gilsonite is remarkable for its unusual geologic origin, chemical and physical properties, and industrial uses. Industry pioneers are noted for creating innovative uses for their product and for over 100 years have solved mining, processing, transportation, marketing, and other challenges to supply gilsonite to world markets. Accordingly, gilsonite has been studied and described in a large body of research dating back to the 1880s. Most recently, the Utah Geological Survey (UGS) published Special Study 141 (Boden and Tripp, 2012), which presents the latest mapping of gilsonite deposits and a compilation of existing data. To date, over 70 significant veins and vein systems, having a total combined vein length of over 170 miles (270 km), have been mapped by UGS geologists.

BACKGROUND

Definitions

Gilsonite is classified as a member of the asphaltite group of hydrocarbon bitumens. This group of naturally occurring solid hydrocarbons are somewhat similar in appearance, occurrence, and properties. Gilsonite occurs in dikes (veins), sills, fractures, and disseminated blebs, commonly in association with Tertiary-age Green River Formation oil shale. Gilsonite has a dull black appearance on weathered surfaces and a shiny black appearance on fresh surfaces. Fractures vary from conchoidal to columnar (pencillated) to flaky or scaly (figure 2). Pencillated textures form at right angles to vein walls and penetrate about 6 inches into the ore (Verbeek and Grout, 1993). Historically, industry defined three major subdivisions of gilsonite based on appearance and melting temperature: selects, seconds, and jet. Select material is very shiny, melts from 300° to 334°F, and tends to occur in the center of the veins. Seconds are somewhat duller, melt from 306° to 361°F, and tend to occur along vein margins, sometimes having pencillated texture. Jet gilsonite has a brilliantly shiny surface, a bluish-black color, and melts from 390° to 446°F (Abraham, 1960). To date, jet has only been found in the Cowboy vein (figure 3).

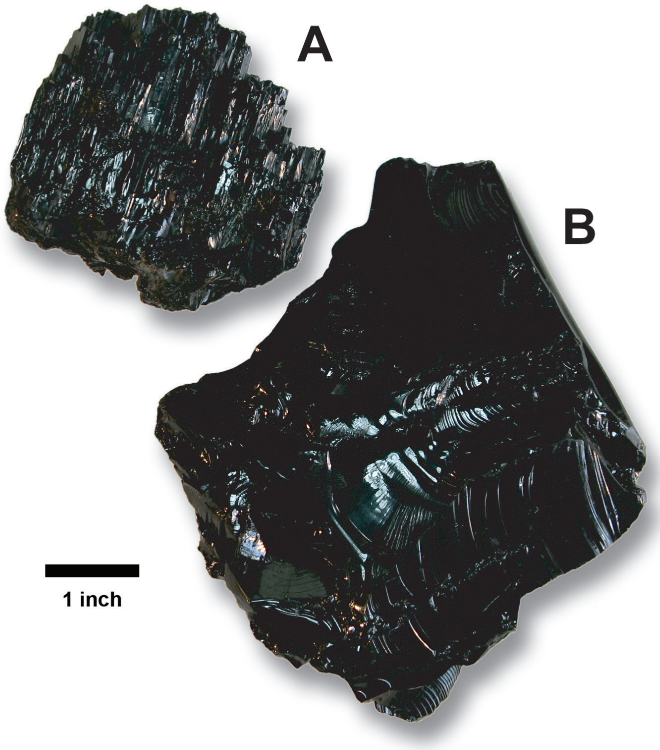
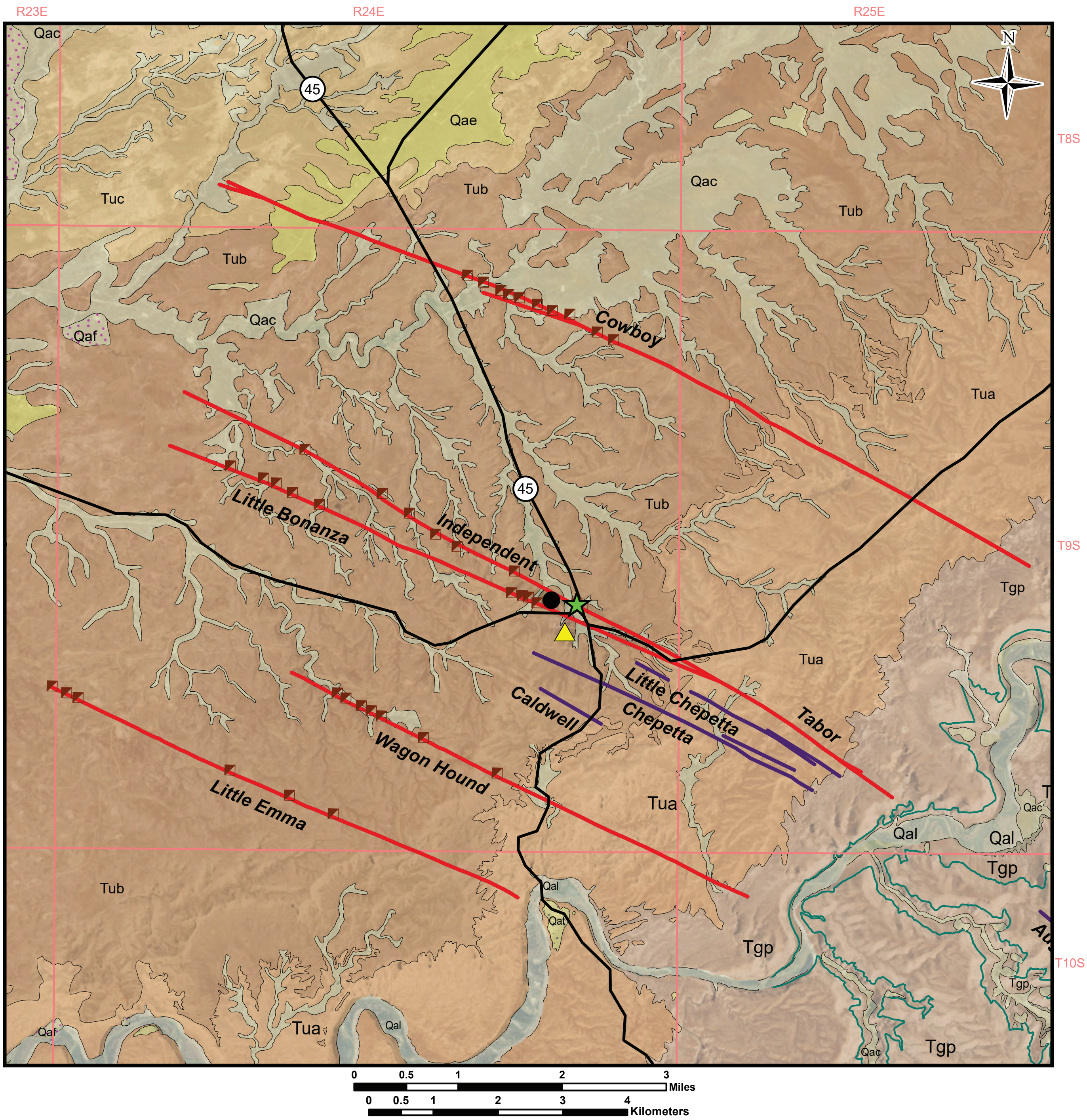


Figure 2. Gilsonite hand samples: A - gilsonite with columnar "pencillated" structure, and B - "select" gilsonite from underground workings on the Independent vein showing conchoidal fracturing.



EXPLANATION

★ Independent vein geosight overlook △ American Gilsonite Company mill ◩ Shaft ● Bonanza, Utah

Geologic Units (modified from Sprinkel 2007, 2009)

— Gilsonite vein
— Gilsonite vein with permitted mining
— Mahogany zone outcrop

Qal	Stream Alluvium (Holocene)	Qat	Stream Terrace Deposits (Holocene and Pleistocene[?])	Tub	Member B of Uinta Formation (Eocene)
Qac	Mixed Alluvium and Colluvium (Holocene and Pleistocene[?])	Qaf	Alluvial-Fan Deposits (Holocene and Pleistocene[?])	Tua	Member A of Uinta Formation (Eocene)
Qae	Mixed Alluvium and Eolian Deposits (Holocene)	Tuc	Member C of Uinta Formation (Eocene)	Tgp	Parachute Creek Member of Green River Formation (Eocene)

Figure 3. Independent vein area mining activity and geology.

Industrial uses of gilsonite can be grouped into five major categories: 1) asphalt paving mixes and coatings, 2) oil and gas well drilling and completions, 3) inks and paints, 4) chemical products, and 5) metal foundry (Boden and Tripp, 2012). Physical and chemical characteristics of gilsonite are important for determining possible industrial applications. Gilsonite from different veins or different parts of veins can be mixed to achieve a product with a specific melting temperature range.

Origins of Gilsonite

Gilsonite deposits primarily occur as long, mostly vertical dikes (veins) (figure 4) that predominantly trend northwest to southeast and can range in width from less than an inch to more than 20 feet (6 m). Horizontal gilsonite sills are occasionally associated with the gilsonite dikes. The source of the gilsonite veins and the mechanism of their emplacement have long been debated and the various theories are well summarized by Verbeek and Grout (1993).

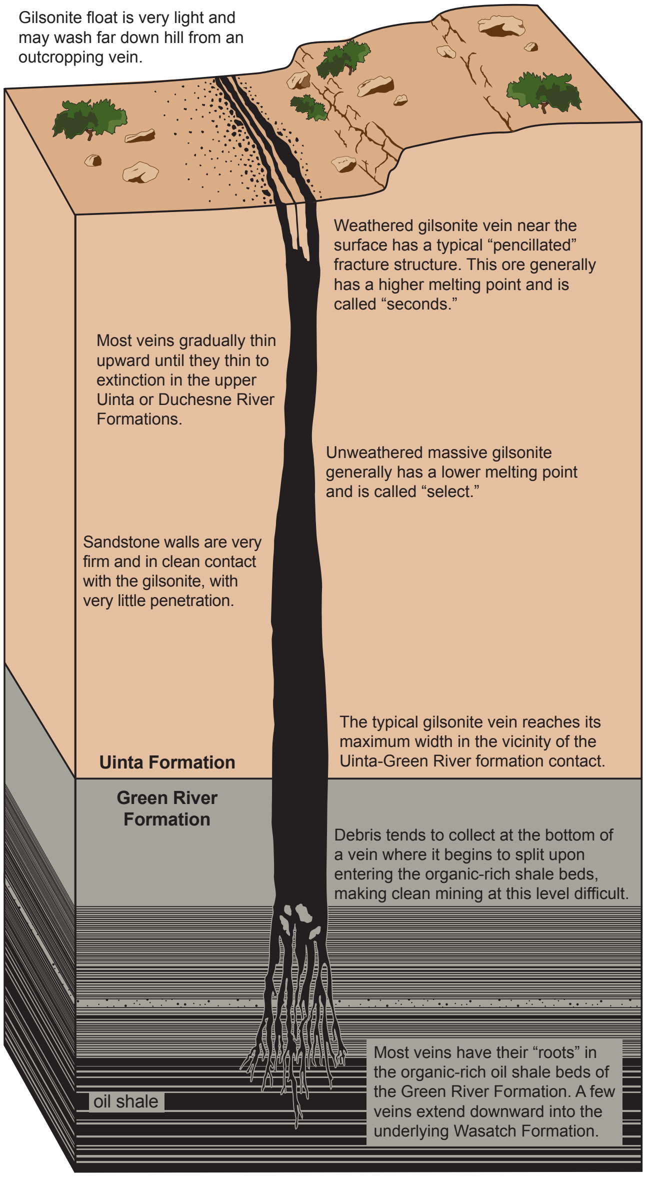


Figure 4. *Cross section of a typical gilsonite vein (modified from Eldridge, 1901).*

Fractures filled by gilsonite veins are large-scale hydraulic extension features that resulted from the over pressurization of pore-space fluid in the organic-rich source beds in the Green River Formation (Verbeek and Grout, 1993). Regional stress fields from early-stage, post-Laramide, regional tectonic extension is also believed to be a factor in allowing fracture formation. Fractures were first forcefully propagated by over pressurized formational water in pore spaces. Subsequently, fractures were widened as viscous, liquid asphaltite generated from deeply buried kerogen was injected under high pressure. The gilsonite later solidified, probably through cooling and polymerization.

Based on laboratory and field evidence it has been proposed that the liquid asphaltite was sourced from kerogen-rich oil shale beds in the Parachute Creek Member of the upper Green River Formation, possibly beds that are deeply buried on the west side of the basin. The Mahogany oil shale zone, which is a sequence of organic-rich (kerogen-rich) dolomitic marlstone in the upper Parachute Creek Member, is a probable major source for the gilsonite (Pruitt, 1961; Cashion, 1967). This interval reaches up to 40% total organic carbon and was deeply buried, especially to the northwest (down to 10,000+ feet), bringing these deposits into the upper ranges of the oil generation window.

History and Mining

Uintahite, the formal scientific name for gilsonite, was first discovered in the 1860s. The material was later informally named gilsonite, after Samuel H. Gilson, due to his enthusiastic development and promotional efforts (Kretchman, 1957; Covington, 1964). The name gilsonite was further solidified in common usage when an early mining company adopted and trademarked the name. Gilsonite has been mined since the late 1880s in the Uinta Basin. The first regular shipments began in 1888 from veins in the Fort Duchesne area. Early mining was predominantly by open-cut excavating (figure 5) with picks, shovels, and horse-powered hoists.

Figure 5. *Historical open-cut mining on the southeast end of the Cowboy vein. View to the southeast.*

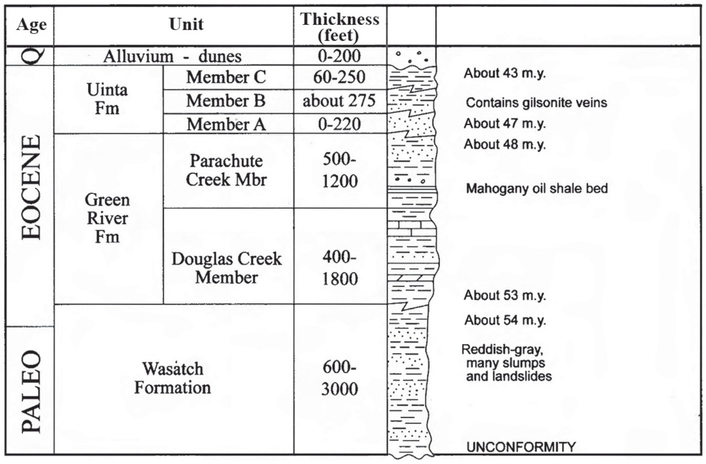
The gilsonite veins actively being mined are near the Bonanza area and were discovered by early prospectors who located surface exposures. Permitted mining currently occurs in the Cowboy, Independent, Little Bonanza, Wagon Hound, and Little Emma veins (figure 3) via underground mining methods. Mining consists of two major phases: (1) shafts are sunk at regular intervals along the veins, and (2) drifts and stopes are then extended laterally from the shafts. The top 30 feet (9 m) of the gilsonite is left intact for safety and reclamation reasons. Gilsonite mining is labor intensive because of its unusual occurrence in narrow (minable widths down to 18 inches), deep, vertical veins, and the explosive hazards associated with gilsonite dust. Mining is still done by hand using air-powered chipping hammers to break the gilsonite while avoiding contaminating the ore with broken wall rock, since product purity is important to customers. The broken ore enters a vacuum tube at the bottom of the underground mine and is air lifted to the surface, where it is dropped into a holding container next to the shaft headframe before being trucked to the processing plant in Bonanza.

Over the past decade, gilsonite production from the Uinta Basin has ranged between 20,000 and 85,000 short tons per year, depending on market conditions, mainly associated with the boom and bust cycles of the oil and gas industry, currently one of the largest markets. The American Gilsonite Company has been the major producer for many years. Cashion (1967) estimated that the original gilsonite resource was approximately 45 million short tons (40.8 million mt); though mining has occurred for many years, millions of tons of resource are estimated to remain. Current resources are becoming more difficult and more expensive to mine as they are in deeper, thinner, and more remote veins.

GILSONITE VEIN OVERLOOK – INDEPENDENT VEIN

The gilsonite veins are in a remote and rugged region and access to some areas is difficult. The Independent (Bonanza), Tabor, and Little Bonanza vein system is exposed near Bonanza, Utah, along Utah State Highway 45, and is one of the easiest and most dramatic places to view the remnants of a gilsonite vein and historical mine workings (figure 3). The Independent and Tabor veins are a single vein, but are called by different names northwest and southeast, respectively, of the junction with the Little Bonanza vein. The remnants of the Independent (Bonanza) vein at the overlook location are exposed in a wide, open-cut trench that stretches across the landscape (figure 6). The Independent (Bonanza) vein is the second widest gilsonite vein in the Uinta Basin and has supported mining operations since the late 1800s (Pruitt, 1961). In the Bonanza area, these veins are exposed in the Eocene-age Member A and B sandstone of the Uinta Formation (figure 7). The Independent/Tabor vein is reported to be more than 7.5 miles (12 km) long, generally strikes from N. 55°–62° W., has a maximum width of 14 feet (4 m), and has an estimated maximum vertical extent of 1100 feet (335 m) (Cashion, 1967).

Figure 6. Overlook of the Independent (Bonanza), Tabor, and Little Bonanza vein system exposed along Utah State Highway 45 at Bonanza, Utah. View to the northwest. GPS coordinates of overlook are: Easting 655864, Northing 4431585.



Age	Unit		Thickness (feet)
Q	Alluvium - dunes		0-200
EOCENE	Uinta Fm	Member C	60-250
		Member B	about 275
		Member A	0-220
	Green River Fm	Parachute Creek Mbr	500-1200
		Douglas Creek Member	400-1800
PALEO	Wasatch Formation		600-3000

Figure 7. Stratigraphic column of the Eocene section that hosts gilsonite veins in the Independent vein area (modified from Hintze and Kowallis, 2009).

This area is accessed by traveling south on Utah State Highway 45 out of Vernal for about 42 miles (68 km). Gilsonite veins and mine workings around the Bonanza area can be observed along public roads but all mining takes place on private property having no public access. The gilsonite mine workings are dangerous and should not be approached; they should always be viewed from a safe distance.

GEOLOGIC SETTING

The Uinta Basin is an asymmetric, intermontane basin along the northern edge of the Colorado Plateau. The basin is bordered by the Uinta Mountains to the north, Douglas Creek arch to the east, Uncompahgre uplift to the southeast, San Rafael Swell to the southwest, and Wasatch Range to the west. Structural features in the Uinta Basin and Uinta Mountains region have a development history that is long and complex; some structures like the Uinta rift basin formed during Proterozoic time and other structural activity possibly occurred during the Pennsylvanian-Permian ancestral Rocky Mountains uplift (Stone, 1993). The Uinta Basin, Uinta Mountains, and associated folds were formed by west-southwest to east-northeast compression during the Cretaceous-early Tertiary Laramide orogeny (Erslev, 1993; Stone, 1993).

On the eastern side of the Uinta Basin in the Bonanza area, gilsonite veins are hosted in the gently dipping Eocene-age strata of the Green River and Uinta Formations (figures 3 and 7). These formations were deposited in lacustrine (Green River Formation) and fluvial (Uinta Formation) environments and range in composition from carbonate rocks to clastic rocks. Contacts are gradational with complex intertonguing relationships and abrupt facies changes that reflect fluctuating paleo-lake levels. The extensive vertical and horizontal continuity of the gilsonite veins is related to the stratigraphy and lithology of the host formations (Pruitt, 1961; Cashion, 1967).

Eocene Green River Formation lacustrine deposits host gilsonite veins in both the basal and upper members. All significant known gilsonite veins are located above the Mahogany oil shale zone in the upper Green River Formation, except two veins that are in the basal member in the southeastern part of the basin (Boden and Tripp, 2012). Gilsonite veins are known to achieve their greatest thickness in the lower Uinta Formation. The Eocene Uinta Formation overlies the Parachute Creek Member of the Green River Formation and consists of marginal lacustrine deposits in the lower members, mixed fluvial and marginal lacustrine deposits in the middle part, and entirely fluvial deposits in the upper part. Marginal lacustrine deposits in the lower part consist primarily of thick, laterally continuous, medium-bedded to massive sandstone containing interbedded siltstone and thin intervals of marlstone and tuff. Fluvial beds in the middle and upper members are composed of channel-form sandstone, variegated mudstone, and minor conglomerate that tend to be laterally discontinuous and thinner than marginal lacustrine deposits down section (Pruitt, 1961; Cashion, 1967). Gilsonite veins commonly split, become discontinuous, and/or pinch out in the mudstone-rich upper Uinta Formation.

SUMMARY

Gilsonite is a unique material that has been mined for well over a hundred years and its geological occurrence and mining history have been studied by numerous researchers in a large body of work. Even though significant amounts of the approximately 45-million-short-ton original gilsonite resource have been mined, millions of tons of the valuable resource remain. Additional resources are likely to be found in the deeper parts of the Bonanza area veins and in thinner, more remote veins that will likely be more expensive to mine. Gilsonite will continue to be mined in the Uinta Basin for decades, ensuring a steady supply to world markets of this unique and valuable Utah resource.

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