Illinois Geologic Quadrangle Map
IGQ Karbers Ridge-BG

Bedrock Geology of Karbers Ridge Quadrangle

Hardin, Gallatin, and Saline Counties, Illinois

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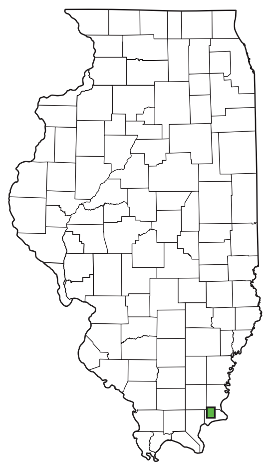
2010



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Introduction

The Karbers Ridge 7.5-minute Quadrangle covers portions of Hardin and Gallatin Counties and a very slight portion of Saline County in southern Illinois. This quadrangle lies in the southern part of the Illinois Basin and near the western end of the Rough Creek Graben, a late Precambrian to Middle Cambrian failed rift structure (Nelson 1995). Portions of this area were previously mapped by Butts (1917, 1925), Weller et al. (1920, 1952), Weller (1940), and Baxter and Desborough (1965). Reports on the Illinois-Kentucky Fluorite District and its mines and minerals have been completed by Heyl et al. (1974) and Goldstein (1997). The field work for this map was conducted in 2009 and 2010 by the authors with additional assistance from Joseph A. Devera, Illinois State Geological Survey (ISGS).

The map that accompanies this report depicts only the bedrock geology of the Karbers Ridge Quadrangle. The oldest rocks that outcrop in the quadrangle are Devonian age along the western edge of the quadrangle at Hicks Dome. Hicks Dome is an uplifted oval structure that lies along a broad northwest-trending structural arch named the Tolu or Kutawa Arch (Baxter and Desborough 1965). Structural uplift of over 4,000 feet at Hicks Dome (Nelson 1995) appears to be related to a crypto-explosive event that produced dikes, sills, and pipe-shaped diatremes, which vented gases to the surface (Brown et al. 1954, Heyl and Brock 1961). Radiometric age dating indicates an early Permian age of about 270 million years ago (Zartman et al. 1967, Fifarek et al. 2001) for these igneous intrusions.

Structure and Tectonics

The general structural fabric in the Karbers Ridge Quadrangle is primarily northeast to southwest. Overall faulting is high-angle normal or dip-slip and produces grabens, which are typically thought to be a result of regional extension. There is some evidence of strike-slip movement along some of the northeasterly faults and reverse movement surrounding Hicks Dome. The southerly projection of the major northeast-southwest–trending faults in the Karbers Ridge area is in line with faults of the Reelfoot Rift and the New Madrid Seismic Zone to the southwest. Neotectonic research along these faults less than 10 miles to the southwest indicates movement may have occurred in the Quaternary sediment and definitely in the Cretaceous units (Nelson et al. 1997). Recurrent tectonism combined with Permian ultramafic igneous activity and hydrothermal mineralization renders this area one of the most complex, in terms of geologic structure, in the North American midcontinent.

The major faults located in the Karbers Ridge Quadrangle are discussed. These faults are very poorly exposed. Information concerning these faults was extracted from both the literature and recent geologic mapping activities.

Colbert Hollow Fault

A fault is present in the northwest portion of the map along Colbert Hollow, which previously has not been described. This fault is mapped as normal, striking N20–25° W, but the amount of offset cannot be ascertained. It appears to be a minor fault and probably has less than 50 feet of displacement within the Pennsylvanian Caseyville and Tradewater Formations. The fault is mapped down to the northeast, but horizontal slickensides (dipping 13 degrees below horizontal to the north) were observed along a segment of this fault at Sec. 30, T10S, R8E; 2,300 feet SL, 500 feet EL. A horizontal "wrench" component is probably present along this fault, which may be related to the Eagle Valley Syncline to the north or Hicks Dome to the south. Here this fault is named the Colbert Hollow Fault. Several pits were observed along the strike of this fault zone, which were probably mineral exploration pits. No evidence of mineralization was observed in the pits.

A fault 2 miles east of the Colbert Hollow Fault was mapped by Weller et al. (1952), but Baxter and Desborough (1965) did not depict this fault on their map. The apparent reason for the structure is an unusual outlier of Kinkaid Limestone. We agree with Weller et al. (1952) that "probably" a small structure is present here that trends northeasterly along Grindstaff Hollow. However, field evidence for this structure is very meager, and the offset on this fault is probably small.

Lee Fault

The Lee Fault is named for the Lee Mine (Sec. 14, T11S, R8E). Weller et al. (1920) states "The Lee fault may be the continuation of the Hobbs Creek Fault and connects through the Hicks Dome to the southwest." The Hobbs Creek Fault Zone comprises high-angle normal faults that trend approximately north 50 degrees east and bound the southeastern edge of the Dixon Springs Graben (Baxter et al. 1967). The vertical offset at the Lee Mine is about 400 feet, and several smaller faults trend parallel with the master fault. It is mapped as normal with the southeast side being downthrown along the length of the northeasterly trending fault zone. The fault is mineralized, and several pits and sealed shafts were observed at this site. A good exposure of the fault surface showing dip-slip striations dipping steeply to the southeast can be observed in the sandstone footwall of an abandoned pit at the Lee Mine. The fault bends in a general westerly fashion as it approaches Hicks Dome where it becomes difficult to trace the extent of this fault. We assume the Permian uplift near Hicks Dome has created a complex fault zone that is difficult to reconstruct. Baxter and Desborough (1965) mapped the Lee Fault through the Hamp Fault and terminated the Lee into the Ridge Fault.

Ridge Fault

The Ridge Fault was first mapped by Baxter and Desborough (1965), and it is named for the Ridge Mine (Sec. 10, T11S, R8E). The fault strikes northeasterly and displacement along this fault is downthrown to the northwest. The fault is poorly exposed, but fluorite prospecting around the Ridge Mine helped to map its extent. Baxter and Desborough (1965) document the displacement diminishing to the southwest with maximum offset of 50 feet. This fault is very poorly exposed, but Nelson (1995) states that it is an extension of the Hobbs Creek Fault Zone and that it merges with the Lee Fault Zone to the south. We could not trace this fault with assurance and indicated its location by a dashed line parallel with the Lee Fault Zone. The Lee Fault exhibits a much larger displacement and is more likely to be the continuation of the Hobbs Creek Fault Zone than the Ridge Fault. The Ridge Fault is certainly a result of a similar stress regime that created the Lee Fault, and both faults may very well be extensions of the Hobbs Creek Fault Zone. The Ridge Fault may merge into the Lee Fault to the northeast, near Sparks Hill, but we could not map the fault much north of the Ridge Mine.

Hamp Fault

The Hamp Fault trends in an arc from the west to east just north of Hicks Dome. It is very poorly exposed and is mapped mostly through mine notes and previous works of Baxter and Desborough (1965), Weller et al. (1920), and Bastin (1931). The fault probably is a result of the vertical uplift at Hicks Dome, and the amount of displacement is less than 100 feet. This fault is extensively mineralized and has been mined along its strike. Bastin (1931) described the veins along the fault to be dipping 60 to 75 degrees to the south. Therefore, this fault is likely a reverse fault with the south side being upthrown. The fault apparently dies out to the east where it cannot be accurately located. The west end of the fault apparently terminates into a N15° W fault that is mineralized but shows only minor offset of the strata (Bastin 1931).

Goose Creek Fault Zone

The Goose Creek Fault Zone, in the southeastern portion of the map, trends northeast-southwest and is a normal fault zone consisting of several parallel faults. These faults are associated with the Rock Creek Graben and probably merge into the Hogthief Creek Fault Zone to the northeast. These faults are normal with displacement down to the southeast several hundred feet. The fault zone appears to die out to the southwest where it cannot be traced. This fault zone is mineralized to the northeast, but no mineralization was observed along the fault zone in the Karbers Ridge Quadrangle.

Wolrab Mill Fault Zone

The Wolrab Mill Fault Zone (Nelson 1995) is located on the horst block between the Dixon Springs Graben and the Rock Creek Graben (see cross section A–A′). Weller et al. (1920) states that the Wolrab Mill Fault is the longest fault in Hardin County, stating that it extends to the southwest into Pope County. The fault trends southwesterly passing south of Hicks Dome and merging with the Stewart Fault Zone in the Shetlerville Quadrangle. The fault is downthrown on the southeast with a maximum throw of 200 feet. The throw decreases near Hicks Dome where it merges into the Stewart Fault Zone in the Shetlerville Quadrangle. This fault was observed at several places along strike, but no evidence for mineralization was observed. The Stewart Fault in the adjacent Shetlerville Quadrangle is extensively mineralized (Denny and Counts 2009).

Hogthief Creek Fault Zone

The maximum displacement in the Karbers Ridge Quadrangle is along the northwestern edge of the Rock Creek Graben where the St. Louis and Salem Limestones are juxtaposed with the Caseyville Sandstone. The fault segment in this area of the southeast corner of the map is named Hogthief Creek, and the vertical displacement offsets the entire Chesterian Series. This offset produces approximately 1,600 feet of vertical displacement. The Hogthief Creek Fault Zone defines the northwestern edge of the Rock Creek Graben. The fault zone is named for Hogthief Creek, which it parallels for several miles southeast of Hicks Dome. The fault is normal with the southeastern side downthrown. There are several faults paralleling this fault zone, some of which are reported to show reverse movement (Nelson 1995), which indicates there may have been several periods of movement along this fault zone. No mineral deposits have been reported along this fault zone.

Economic Geology

Illinois-Kentucky Fluorite District

Economic mineralization in the Illinois-Kentucky Fluorite District (IKFD) is dominantly composed of fluorite with lesser amounts of sphalerite, barite, and galena. Other minerals identified in this district are pyrite, chalcopyrite, quartz, celestite, cerussite, greenockite, malachite, smithsonite, witherite, strontianite, benstonite, and alstonite (Goldstein 1997). The ore bodies occur as bedded deposits, formed by selective replacement of limestone strata, vein deposits along faults and fractures, and residual deposits derived from veins or beds. The residual deposits are known as "gravel spar" and were worked at both the Rose Mine and the Hamp Mines. Most deposits within the area of this map are mainly of the vein type along faults of slight to moderate displacement. In some workings, however, a small amount of replacement ore has been observed along the wall rock. The best indication of the replacement type of ore deposition is the identification of remnant textures present in the fluorite that were formerly present in the limestone. Replaced fossils, styolitic sutures, and primary bedding characteristics have been reported as being present in replacement ore in this region. Mine run ore commonly contains from 30 to 40% fluorite, and at places it contains 2 to 3% zinc. Some deposits contain a small percentage of silver in the galena and recoverable cadmium and germanium in the sphalerite (Trace and Amos 1984). The amount of sphalerite in some ore bodies within the IKFD is considerable. The ore at the Hutson Mine near Salem, Kentucky, was almost exclusively sphalerite associated with ultramafic igneous dikes

(Osterling 1952). Ultramafic igneous activity underlies the mineralized area of the IKFD from northwestern Kentucky into southeastern Illinois.

Mineralization within the IKFD probably results from an acidic basinal brine fluid, charged with fluorine and carbon dioxide from Permian alkaline magma (Plumlee et al. 1995). These basinal brine-type fluids were funneled along the northeastern-trending fractures and fault zones, possibly during periods of major regional tectonic adjustments. Disequilibria within the acidic fluids occurred when the fluids came into contact with the calcium-rich carbonate formations where the ore precipitated (Denny et al. 2008). The ore of the IKFD is almost always in contact within or adjacent to a carbonate host rock.

Several fluorite mines and prospect pits were located in this quadrangle. There was substantial production from the Hamp Mines, Lee and Hillside Mines, and the Ridge Mine. These mines were all vein-type deposits with mineralization along faults of slight to moderate displacement. Fluorite, sphalerite, barite, and galena were reported along with abundant calcite gangue. The majority of the mineralization was open space filling of fractures with minor replacement of limestone host along the fault boundaries. These mines, which have all been abandoned, are labeled on the map sheet and described herein.

Hamp Mines

There are several shafts along an east-west–trending fault at this location (Secs. 18 and 7, T11S, R8E). The veins are reported to dip to the south between 60 and 75 degrees and to be worked to about 100 feet deep. Two open cuts are present that mined bedded fluorite, and local residents reported mining gravel spar in this area. Just off the west edge of the Karbers Ridge Quadrangle, a vein striking N15° W was reported to be mined. Weller et al. (1920) reported that this vein was along a fracture and that little to no displacement could be observed across the vein. Bastin (1931) reported that the mine was first opened in 1897 and that 7,000 to 8,000 tons of fluorite were produced at this location. A mill was also present, but no indications of the mill site were observed.

Lee Mine

There are several shafts and an open cut located at the Lee Mine (Sec. 14, T11S, R8E). Two shafts at the top of the hill are named the Hillside Mines. The vein was reported to be about 7 to 8 feet wide striking N58° W and dipping to the southeast at about 70° W (Bastin 1931). There are several shafts and pits at this abandoned site. A foundation along the top of the hill may be the location of the former mill that reportedly contained a roller crusher, jig, and log washer. The shafts were reported to be sunk up to 100 feet deep. A sample of this ore was taken for geochemical analysis (see sample KR-1, tables 1 and 2, and figure 1).

Lacey Mine

The Lacey Mine (Sec. 6, T12S, R8E) is also listed as Big Creek Fluorspar Company and A.B. Mann. Very little information is available concerning these prospect pits. Some purple spar was observed along with calcite in prospect pits in this region. A sample of this ore was taken for geochemical analysis (see sample KR-2, tables 1 and 2, and figure 1). Several pits were located, and some green copper mineralization was observed associated with calcite and fluorite around the pits.

Ridge Mine

The Ridge Mine (Sec. 10, T11S, R8E) is located east of the Lee Mine along a northeastern-trending fault. The shaft has been sealed with a concrete cap, and there is an open pit north of the sealed shaft. No production figures are available for this operation.

Table 1 Geochemical analysis[1] for rare earth and other trace elements from outcrops in the Karbers Ridge Quadrangle.

Sample	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Y
KR-1	3.9	11	1.9	9.2	2.6	1.2	2.7	0.4	2.1	0.4	0.9	0.1	0.5	0	16
KR-2	30.2	79.6	10.9	48	12	5.6	11.5	1.9	11.1	2.6	7.2	1.1	7.3	1	94.2
KR-3	293	467	45.5	143	17.6	4.3	17.2	1.7	6.7	1.3	3.6	0.4	2.5	0.3	29.9

Sample	Ag	Ba	Co	Cr	Cs	Cu	Ga	Hf	Mo	Nb	Ni	Pb	Rb	Sn	Sr
KR-1	8	18	1.9	20	0.03	269	0.5	0.4	ND	3.3	17	**	1.5	ND	161
KR-2	ND	19.8	1.1	10	0.11	1170	1.4	0.6	ND	2.7	9	238	4.1	4	203
KR-3	3	597	15.3	30	0.77	9	13.5	7	3	155	16	59	35.4	2	1315

Sample	Ta	Th	Tl	U	V	W	Y	Zn	Zr
KR-1	0.2	0.3	ND	0.1	10	1	16	ND	21
KR-2	ND	1.1	ND	0.2	9	1	94	ND	28
KR-3	5.8	13.8	ND	5.6	135	3	30	107	310

[1]Samples analyzed by ALS Chemex, Reno, Nevada, using the ME-MS81 method. Values are in parts per million. Abbreviations: ND, less than detection limit; **, greater than 10,000 ppm. Detection limits can be obtained from ALS Chemex.

Rose Mine

The Rose Mine (Sec. 30, T11S, R8E) is located along the southeast side of Hicks Dome and mined gravel spar. Several pits were dug, the deepest of which reached to 100 feet below the surface. Indication of these pits is present, and a small amount of fluorite was found scattered throughout the area. Bastin (1931) reported that the mine was not along a fault, and a small steam shovel mined residual ore pockets. We mapped a fault in the Ft. Payne Formation approximately 2,000 feet to the northeast, which appears to project into this mine site. Exposures in this area are very limited.

Prospect Pits

Additional prospects and mines are present, but most are small exploration pits with very limited historical data. These pits and prospects, which probably produced only limited amounts of fluorite, are listed. These pits have mostly been filled in or have collapsed. The majority of these data were extracted from Obrad (2005).

Weidman Fluorspar Prospects (Sec. 7, T11S, R8E) are located north of the Hamp Mines along a small north-trending fracture or small faults. Several pits, none exceeding 25 feet deep, are located in this vicinity. We found evidence for these prospects and some fluorite in the stream gravel.

Carnett Fluorspar Prospect (Sec. 7, T11S, R8E) is also listed as the George Carnett Mine. This pit is listed as a small shaft extending 30 feet below the surface. Just east of the Carnett pit, the Williams Fluorspar Prospect was sunk.

The Williams Fluorspar Prospect (Sec. 7, T11S, R8E) was also listed as the Beecher Williams Mine and was a shaft approximately 30 feet deep.

The Gintert Fluorspar Prospects (Sec. 17 and 8, T11S, R8E) are located east of the Williams Fluorspar Prospects. The Gintert Mines are composed of pits or shafts between 30 and 70 feet deep. The Gintert Mines are also listed as Beecher Williams.

Frohock Prospect (Sec. 17, T11S, R8E) is also listed as Williams and LaRue. There are no additional data concerning this prospect pit.

The Diamond Fluorspar and Lead Prospect (Sec. 17, T11S, R8E) is also listed as George Carnett. This mine is reported to have a single shaft extending between 40 and 125 feet below the surface.

Turner Fluorspar Prospect (Sec. 21, T11S, R8E) is also listed as the Saylor and Potts Mine. The one pit at this location is approximately 40 feet deep.

The Joyce Prospect (Sec. 21, T11S, R8E), also listed as Thurmond and Gibbons, is reported to consist of one shaft approximately 48 feet deep.

The Renfro Fluorspar Prospect (Sec. 23, T11S, R8E), also listed as Barnett or Hastie Prospect, is reported to be one pit 22 feet deep.

Several pits along a fault splay of the Lee Fault (Sec. 11, T11S, R8E) are listed as the Love Fluorspar and Lead Mines. These mines are also listed as McAllister and Phelps, and all were small pits or shafts less than 50 feet deep.
The Jarrells Fluorspar Prospect (Sec. 12, T11S, R8E) is also listed as the Love Mine. A 60-foot-deep shaft is reported to be present at the Jarrells Fluorspar Prospect. Several other pits are present, but no additional information is available other than their locations.

Iron Ore

Iron ore is present and was mined in this region. This ore was mined during the mid to late 1800s and smelted at the Illinois Iron Furnace, which is located just south of the Karbers Ridge Quadrangle. Pig iron was reportedly produced from the Illinois Iron Furnace until 1883. Several large round “botryoidal” clusters of limonite were observed in a creek (Sec. 34, T11S, R8E; 2,300 feet NL, 1,300 feet WL), but the source was not located. The ore was reportedly abundant in residual clay along the top of the Ste. Genevieve and St. Louis Limestones (Baxter and Desborough 1965). These deposits were aligned along northeast-trending faults, but the geologic relationship has not been studied.

Oil and Gas

The Illinois Oil and Gas database lists two holes that were drilled in this quadrangle to test for oil and gas near the apex of Hicks Dome. Both were dry and abandoned. The Fricker well (Sec. 30, T11S, R8E) was drilled in 1935 to a depth of 3,306 feet. It was drilled by Northern Ordnance Inc. and also listed as Maretta Oil Company. The well was dry and was abandoned. The Hamp well (Sec. 30, T11S, R8E) was drilled in 1952 and was also dry and abandoned. Although this well is listed as an oil well, it was drilled by the St. Joseph Lead Company and probably was an exploration boring drilled to 2,948 feet. Four cores were taken in the Kimmswick (“Trenton”) Limestone.

Stone

Limestone has been mined in this quadrangle at a few small pits. Gravel also has been produced from weathered residuum of the Fort Payne Formation at a few sites surrounding Hicks Dome. Pennsylvanian “flaggy” sandstone has been mined at a few very local sites, mostly for stepping stones or walkways. There are substantial quantities of limestone in this quadrangle that could be mined through open pit quarries. The Ste. Genevieve, St. Louis, and Salem Limestones are present at the surface surrounding Hicks Dome. These limestones are mined extensively in surface operations to the south in the Rosiclare and Shetlerville areas. Obstacles for quarry development in the Karbers Ridge Quadrangle include a lack of transportation infrastructure to efficiently ship the product to market. Additional concerns are from the major fault zones and the development of karstic areas.

Coal

There has been a small amount of coal mined in the northeastern portion of the quadrangle. The Willis Coal of the Tradewater Formation is mined both underground and at the surface. The underground Willis Mine (Sec. 30, T10S, R9E) operated from 1906 to 1907. The coal was named after the mine by Butts (1925). This mine was also known as the Blue Blaze, Schneider, Shawnee, and Peacock mines, which were operated from about 1923 to 1966. The Willis Coal attains a thickness of about 40 inches in this area but is cut out in places by the overlying sandstone. It also may have shale partings in places. Northwest of the Blue Blaze Mine, this coal seam has been mined along the contour of the hillside. The coal can be observed in the creek bank (Sec. 30, T10S, R9E; 2,000 feet SL, 2,200 feet WL) near the abandoned surface mine. The Delwood Coal (Sec. 30, T10S, R9E) and the Reynoldsburg Coal have been reported in this area (Baxter and Desborough 1965) but are less than 12 inches thick and are discontinuous. The Gentry Coal Member of the Caseyville Formation is also reported to be present (Secs. 6 and 7, T11S, R9E), but was not observed during this mapping project. It is also reported to be discontinuous and less than 12 inches thick in this area (Baxter and Desborough 1965).

Other Minerals

The ultramafic pipes and diatremes may host concretions of economic minerals. Of note is the potential for these igneous rocks to provide a source of rare earth minerals. The major source of rare earth oxides (REO) in the United States comes from a carbonatite intrusion with extraordinary contents of

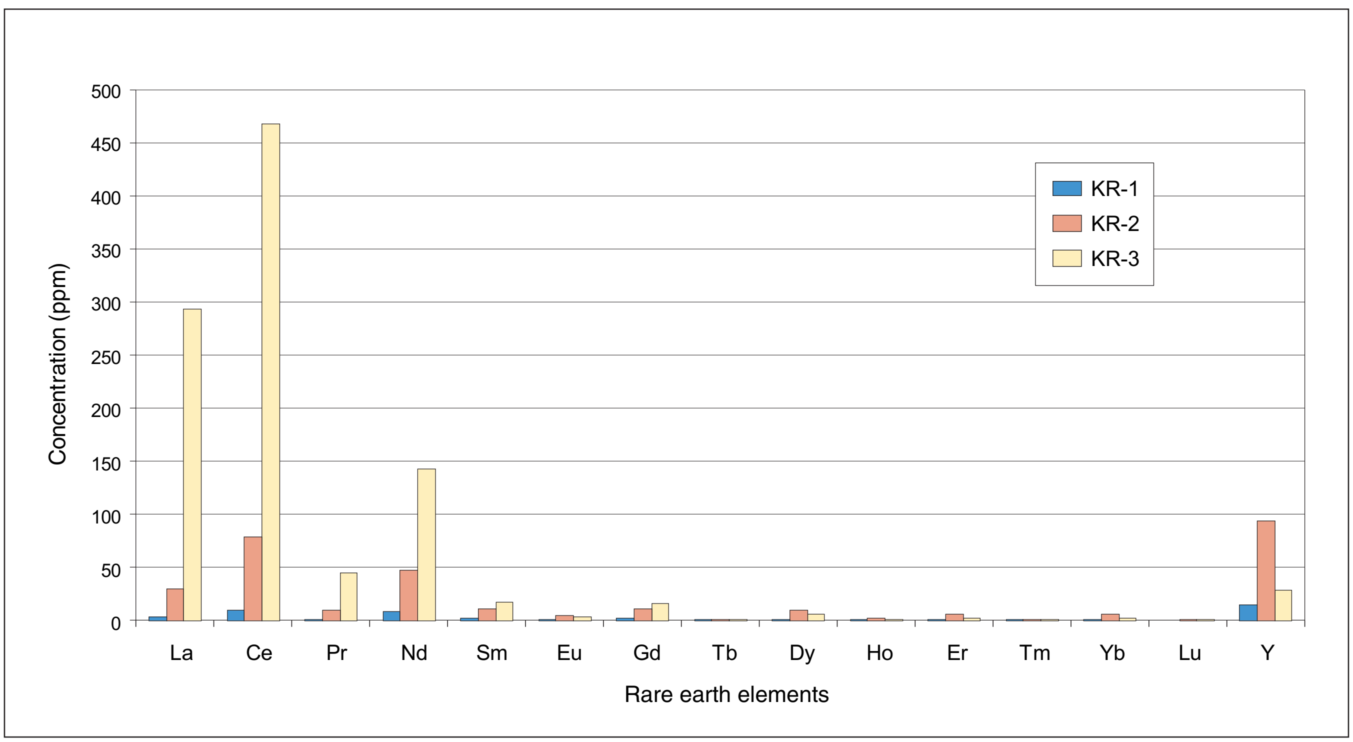
Table 2 Major oxide (whole rock) and fluorite analysis[1] from outcrops in the Karbers Ridge Quadrangle.

Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	Cr_2O_3	TiO_2	MnO	P_2O_5	SrO	BaO
KR-1	6.87	0.09	0.31	52.9	0.21	0.02	0.01	(-)	0.02	0.04	0.04	0.02	(-)
KR-2	12.75	0.53	0.57	50	0.31	0.02	0.14	(-)	0.04	0.01	0.01	0.03	(-)
KR-3	36.9	7.32	7.01	15.2	5.8	2.13	1.42	0.01	1.19	0.2	0.79	0.17	0.07

Sample	LOI	Total	F
KR-1	32.2	92.7	7.47
KR-2	36.7	101.2	1.33
KR-3	21.4	99.6	0.1

[1]Samples analyzed by ALS Chemex, Reno, Nevada, using the ME-ICP06 method. All values are in percent. Abbreviations: ND, less than detection limit; LOI, loss on ignition. Fluorine was analyzed using F-ELE82. Detection limits can be obtained from ALS Chemex.

Figure 1 Rare earth element concentrations.



light rare earth elements (8 to 12% REO) at Mountain Pass, California (Haxel et al. 2002). The rare earth elements at Mountain Pass are hosted chiefly by bastnäsite.

Rare Earth Elements

We sampled three rocks in this quadrangle to assess the possibility of rare earth mineralization. Two samples were taken of hydrothermal low-grade fluorite ore. We chose mostly calcite host material that was mineralized with fluorite and metals. The third sample was from an igneous autolithic breccia or diatreme. The breccia was oxidized and the surface was coated with iron oxides. These rock and ore samples were collected and analyzed for major oxide, fluorine, and trace elements including rare earth minerals. The technique utilized inductively coupled plasma mass spectroscopy (ICP-MS) for whole rock analysis and inductively coupled plasma atomic emission spectroscopy (ICP-AES) for trace elements and rare earth analysis. The results of these analyses are reported in tables 1 and 2 and figure 1. Sample KR-1 is from the Lee Mine complex (Sec. 14, T11S, R8E). The sample is composed of ore stage calcite and colorless fluorite with galena veining. Sample KR-2 is composed of ore stage calcite and minor purple fluorite from a prospect pit southeast of the Lacey Mine (Sec. 6, T12S, R8E). Sample KR-3 is from the Sparks Hill Diatreme (Sec. 13, T11S, R8E) and is composed of an autolithic breccia “igneous diatreme.”

A plot of rare earth element concentration was completed and reported as figure 1. The highest values from the three samples were from the igneous diatreme at Sparks Hill (KR-3). These values are interesting and suggest more sampling of the igneous breccias in the region should be undertaken. The values from the calcite/fluorite ore were less encouraging.

Acknowledgments

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