Bulletin of the Mineralogical Society of Southern California

Volume 75 Number 3 **March 2005**

The 805th Meeting of The Mineralogical Society of Southern California

"Geology, Mineralogy, and Mining History of Searles Lake"

by Stephen P. Mulqueen

Friday, March 11, 2005, at 7:30 p.m.

Friday, February 18, 2005, at 7:30 p.m.
Geology Department, E-Building, Room 220
Pasadena City College
1570 E. Colorado Blvd., Pasadena

Inside this bulletin

March Topic: Searles Lake Mining and Minerals

Stephen P. Mulqueen will present a talk on the geology, mineralogy, and mining history of Searles Lake at the March 11, 2005 meeting. Come and learn more about the stratigraphy and evaporite mineral deposits of the of lake, the history of mineral extraction (1873 to present), present day solution mining operations, industrial mineral production, and mineral reserves for the future. There will also be hints about mineral collecting during the "Gem-O-Rama" (held in October of every year). Further details are in the abstract below.

Steve and his wife Susan currently live in Ventura. Steve has worked over 23 years as an Oil & Gas Engineer with the State of California's Division of Oil, Gas and Geothermal Resources. He earned a Bachelor of Science degree in Geology at Cal Poly, Pomona in June 1978. As an undergraduate, Steve developed an interest in industrial minerals, mining geology and mining history. He was employed at American Borate Company's Billie Mine in Death Valley from 1978 to 1979. In Trona, Steve worked as a geologist for Kerr-McGee Chemical Corporation at their Searles Lake operations from 1979 to 1982.

Solution Mining at Searles Lake, Trona, CA

By Stephen P. Mulqueen

Searles Lake is an evaporite basin located near the community of Trona in San Bernardino County, CA. Searles Valley Minerals currently extracts 1.7 million tons of industrial minerals each year from several lakebeds within the basin.

Searles Lake is one of a chain of Pleistocene lakes that extends from Owens Lake to as far as ancient Lake Manly in Death Valley. The stratigraphic record at Searles Lake indicates that it once held brackish water as deep as 200 meters (650 feet). Fluctuations in lake levels correspond to the advances and retreats of glaciers in the Sierra Nevada Range. Thirty major lake levels occurred during the last 150,000 years, represented by a sequence of salt and mud beds. The precipitation of minerals occurred during long periods of lake evaporation.

Borax was first produced from the dry lake surface in 1873 by John Searles under the name of the San Bernardino Borax Mining Company. Searles was the first to haul borax using the famous 20 mule team wagons. In 1873, before the railroad was built to Mojave, refined borax was hauled 175 miles by 20 mule teams from Slate Range Playa (now called Searles Lake) to the harbor at San Pedro.

Searles Lake is a huge resource of sodium and potassium minerals of the carbonate, sulfate, borate and halide classes of mineralogy. The manufacture of industrial minerals involves a complex solution mining operation in which naturally occurring brines are pumped from wells completed in several salt beds. The brine wells range in depth from near-surface to over 100 meters below the salt pan. A network of production wells, injection wells, solar ponds and piping are used in the production and treatment of the brines.

Industrial minerals are extracted from the brines at the Argus, Trona and Westend plants. Minerals are crystallized from the brines, screened, washed, and dried. The crystals are then baked in rotary kilns in order to drive off water molecules locked in the crystalline structure. Some recrystallization may be required in order to achieve a desired composition and granular density. This complex extraction process at the 3 plants is generally referred to as fractional crystallization. It includes the treatment of brines through carbonation extraction, refrigeration extraction and/or solvent extraction. Salt is also harvested from the lake surface and from solar ponds with use of heavy equipment.

Commodities produced by Searles Valley Minerals from their Searles Lake operations include borax, V-Bor (borax with 5 moles of water), anhydrous borax, boric acid, soda ash, salt cake and salt. Mineral reserves exceed 4 billion tons.

Written February 15, 2005

Minutes of the February Meeting

The 804th meeting of the Mineralogical Society of Southern California was held on Friday, February 18th in the Geology department at Pasadena City College. President Bill Besse brought the meeting to order at 7:27pm. This rainy evening had an especially high turnout with guests eager to become new members. The night began with announcements regarding upcoming shows that are posted in the bulletin's calendar of events.

After the announcements some of the members gave a brief show and tell. John Siefke showed some incredible inyoite specimens. Ken Raabe then discussed his experience with epithermal deposits and passed around rock fragments that contained gold. Walter Margerum displayed a calcite and plattnerite crystal specimen (including pictures), and Charlie Freed passed around a lovely green microcline from Burma that he recently acquired in Tucson.

The evening's speaker Dr. Robert Stull was then introduced by Janet Gordon. Dr. Stull, an igneous petrologist, discussed how magmas form through decompression melting as well as past historical perspectives on the subject. Dr. Stull also brought several hand specimens for the members to inspect including a rather lovely eclogite. The meeting came to a close at 9:10pm.

Respectfully submitted by Ilia Lyles, Secretary

A Specific Test for Sulfides and Sulfo-Salt Minerals: The Iodine-Azide Reaction

By Dr. Charlie A. Crutchfield

This article describes a little known simple spot test for the presence of sulfide and sulfo-salt minerals. Solutions of a mixture of sodium azide [NaN_3] and iodine [I_2] are stable indefinitely (in my personal experience, 3 years at least). But in the presence of any substance, liquid or solid, containing the sulfide ion [S^{-2}], such as a sulfide mineral, there will be a reaction with the slow evolution of bubbles of nitrogen gas [N_2], and the dark red-brown solution will lose color as the iodine is consumed.

This reaction will also occur with thiosulfates [$S_2O_3^{-2}$] and thiocyanates [CNS^{-1}]. and organic thio-compounds.

$$2\ NaN_3 + I_2 = 2\ NaI + 3\ N_2$$

I have used this test successfully on realgar, cinnabar, millerite, covellite, sphalerite, molybdenite, pyrite, and marcasite; and also on the sulfo-salt minerals tetrahedrite, proustite, djurleite, cylindrite, arsenopyrite, teallite, and sarabauite. Pyrite and molybdenite react with this reagent only very slowly, but they do react. There will be no reaction with sulfates [SO_4^{-2}], sulfites [SO_3^{-2}] , elemental sulfur [S], or tellurides [Te^{-2}], and selenides [Se^{-2}]

The reaction differs from the reaction of, say, hydrochloric acid for detecting carbonates by the evolution of carbon dioxide gas bubbles with dissolution of some of the mineral. It is a catalytic reaction, and it reacts to the presence of minute traces of any sulfide with no apparent effect or mark on the mineral. However, because elemental iodine is an oxidant, if it is applied directly to a specimen, when you are done it is advisable to blot the liquid off with paper and then rinse with a little water and reblot to remove any residual chemical.

<u>The test solution</u>:

Sodium azide [NaN_3] solid

Iodine solution, about 0.1 Normal,

Dissolve about 3 grams of Sodium Azide in 100 ml of

the 0.1 Iodine solution.

To make 100 ml of 0.1 N iodine solution, dissolve about 2 grams of potassium iodide [KI] in about 5 ml of water, then add to this about 1.2 grams of elemental Iodine [I_2] and add water to make 100 ml of solution. The concentrations and amounts are not critical, [+/-] 10 % is close enough. The 0.1 N iodine solution can be obtained from any chemical laboratory or chemical supply house, it need not be accurately standardized at all.

Place a small amount of the solution in a clean plastic dropping bottle for use. Keep the remainder in a sealed plastic container in a cool dark place as a reserve. Do not use a dropping bottle with a rubber bulb; these often contain sulfur compounds.

<u>Procedure:</u>

Place a few grains from scrapings of the mineral in a spot plate depression, a small test tube, a watch glass, saucer, or piece of glass. Any article of glass or non-porous ceramic will do

Apply a drop of the iodine/azide test solution to these fragments.

Observe the reagent drop closely (a lens is useful) for the appearance of gas bubbles on the grains. This indicates the presence of a sulfide or sulfo-salt mineral. The dark red-brown color of the liquid may become pale yellow as the iodine is destroyed.

Caveat

The reagent is stable indefinitely. However, if a speck of a sulfide mineral should enter the closed container the reaction will occur, nitrogen gas will be liberated, and the resulting gas pressure may rupture the container causing spillage.

The 0.1 N iodine solution can be obtained easily from any commercial or college laboratory. To obtain the sodium azide can be a problem. It is on the government's list of controlled hazardous chemicals since it can be used to make explosives.

Hazards

The free element iodine is poisonous, and so is sodium azide. The iodine vapors given off by this reagent are irritating and toxic. It is less harmful than the bottle of "Tincture of Iodine" that was in every home medicine cabinet for years in the past.

For more technical information on the chemistry of this little-known reaction see "Spot Test in Inorganic Analysis" by Dr. Fritz Feigl, or any other texts on spot tests by Feigl. ***************

Minerals of the Reward Mine

Or What's in a Name?

by Walt Margerum

The Name and History

Reward, Brown Monster, Ruth, Graham-Jones, Eclipse, and F. D. Roosevelt are some of the names given to the mine shown on maps as the Reward mine. The most important names from an historical perspective are Eclipse, Brown Monster, and Reward. I will try to explain how they all refer to the same mine, and why the literature still refers to both the Reward and the Brown Monster.

The Reward mine is located in Owens Valley California on the west slope of the Inyo Mountains just to the east of Manzinar. This is a very historic part of the valley, being the location of some of the earliest mineral discoveries, as well as the site of the Manzinar Detention Camp during WWII.

According to Chalfant (1933), the Eclipse was discovered in 1860 along with the Union and the Ida, and work was started in the summer of 1862 by R. S. Wigham. The most probable reason for the delay was the numerous conflicts between the white settlers and the local Native American population of Owens Valley. These conflicts continued until 1866. Chalfant gives a somewhat disjointed but none-the-less interesting description of them. Goodyear (1888) describes the Eclipse mine in the log of his travels in the early 1870's published in the Eighth Annual Report of the California State Mineralogist in 1888. He states that the owners at that time purchased the mine from the Union Company, but does not say who they were. From this it can be deduced that sometime before 1870 the Eclipse became part of the Union Company, and it was then sold to new owners. Knopf (1912) provides a description of the mine from about the time of Goodyear until 1912, and states that it was then under the ownership of the Reward Consolidated Gold Mining Company. Hence its present name.

Joel Briggs, in his Desert Drifter web site, provides the following history of the Reward mine. *"In 1871, the Eclipse was sold, and the new owners changed its name to the Brown Monster Mine. Shortly after that, the six-stamp mill was replaced with a 30-stamp mill, which was driven by waterpower generated by water diverted from Owens River. Because of economic reasons, in 1905 a 20-stamp was erected to replace the 30-stamp mill and was moved closer to the mine openings. A tram system was installed to bring ore down to this mill eliminating the need to transport ore away from the mines. In 1911 the mine and plant were overhauled and an electric transmission line 4 1/2 miles long was constructed across the Owens Valley to furnish power. After a short run, the mine was closed in the spring of 1912, pending change of ownership. From 1913 to 1936, the mine was worked on and off with some of its ore being shipped to the Tropico mill at Rosamond for refining and smelting. Considerable exploration was done from November 1940 to April 1942 with several hundred feet of drifts and crosscuts driven, and core drilling done through out the mines. The end results were not favorable and the mine stayed idle until 1948 when a vein carrying lead, silver and gold was discovered in the upper part of the Reward. The vein played out in 1950. In the same year, a small mill was erected to concentrate on some of the lower grade ores, and within nine months, this to was also abandoned for economic reasons, and the Reward Mine once again became dormant. In 1979, the Missouri Mine, Inc. did intense diggings, cyanide testing and core sampling on the Reward Mine. Their findings showed some promise and investigations are still under way to determine feasibility on a full-scale operation."* I wish to thank Joel for his permission to reprint this history.

According to BLM records Missouri Mines, Inc. of Sherman Oaks California still holds active claims in the area.

The Geology and Mineralogy

Although the Reward was primarily a gold mine, it also produced lead, silver, and copper. Knopf (1912) refers to two separate veins in the mine, the Brown Monster and the Reward, and states that the Brown Monster vein is to the north of Reward Gulch, and the Reward vein is to the south. It should be noted that current USGS topographic maps refer to Reward Gulch as Eclipse Canyon. Subsequent writers have kept to this vein distinction when referring to the Reward mine. Knopf provides the following description of the geology of the mines.

"The country rock in the vicinity of the Reward mine consists of a stratified series of limestones of Carboniferous age, but to the southwest there are Triassic rocks, which form the low hills that project through the alluvium of Owens Valley. The strata strike generally northwest, but as they have been intensely folded the dips are extremely variable. The folding is displayed in diagrammatic perfection on the north side of Reward Gulch; in the bottom of the gulch the strata stand vertical, and near the level of the Brown Monster outcrop they are sharply bent and dip west at a low, angle.

A few hundred yards east of the mine, at an altitude of 5,000 feet, is exposed *intrusive diorite which is part of the great granitic mass making up the western flank of the Inyo Range for a considerable distance to the north. In consequence of the intrusion the limestones in the vicinity of the mine have been considerably metamorphosed and are either tremolite bearing marbles or dense-textured lime-silicate hornstones. Dikes and sills have been injected, one of which, 10 feet thick and approximately 50 feet above the vein, is particularly noteworthy because, being easily traceable on the surface, it furnishes an index of the character and amount of the faulting that the Reward vein has undergone. A limestone bed a foot thick, lying above the diorite sill, has as a result of metamorphism been recrystallized to a coarse-grained aggregate of diopside, tremolite, and calcite.*

The Reward vein conforms approximately to the bedding of the inclosing rocks. The hanging wall, as seen above the outcrop, is a stratum of dark-blue siliceous limestone 5 feet thick, which locally is considerably brecciated. The vein can be traced south of the gulch for 400 feet, beyond which it forks and the branches pinch out abruptly. Near the surface the vein lies nearly flat, but at the face of the lowermost drift it dips 40° NE. and strikes N. 40° W. The vein swells and pinches abruptly, ranging from a few inches to 10 feet in thickness with an average thickness of 4 feet.

The ore is a coarse white quartz generally devoid of sulphides. On some of the levels the Reward vein shows large solid bunches of coarsely crystalline galena and some pyrite, chalcopyrite, and sphalerite. These last, however, are extremely rare, and the total quantity of sulphides is only a small fraction of 1 per cent of the ore. Oxidation products occur to some extent, limonite, ferruginous jasper, chrysocolla, cerusite, anglesite, the deep azure-blue linarite, and the bluish-green caledonite, the last two of which are rare basic sulphates of lead and copper.

The Brown Monster vein can be traced more or less continuously for 1,000 feet northwestward from Reward Gulch. In the underground workings it displays the same general features that it shows along the outcrop, being in places a solid and well defined quartz vein and in others mixed with country rock. In the upper levels the vein dips 25° E., but in depth it steepens and near the bottom of. the incline the dip increases abruptly to 50°. The vertical depth attained on the vein is 200 feet."

One good source for mineral information is the mindat.org database created by Ralph Jolyon. This database lists 23 minerals from the Reward. My research has added 15 more minerals giving a total of 38. It should be noted that Paul Adams has written several excellent articles published in Mineral News that are the basis for many of the minerals listed in the mindat.org web site for the Reward mine.

Table I summarizes the minerals. Those <u>underlined</u> are listed on the mindat.org web site as having been verified as occurring at the mine. Those in **bold** have been verified by the author, and those in *italics* by Bob Housley and his magic machine. The remainder are from the literature, primarily Goodyear, and Knopf. As you can see there is some overlap of verification, and a few unverified minerals.

Although many excellent cabinet specimens have been obtained from the mine in the past, most recently reported minerals are micro's. Many of these are well crystallized, and make excellent specimens.

As stated earlier Missouri Mines inc. holds active claims in the area, and their rights should be respected.

Table I. Minerals of the Reward Mine

Anglesite $PbSO_4$	*Arsentsumebite* $Pb_2Cu (AsO_4)(SO_4)(OH)$	Azurite $Cu_3(CO_3)_2(OH)_2$
Beudantite $PbFe_3(AsO_4)(SO_4)(OH)_6$	***Brochantite*** $Cu_4(SO_4)(OH)_6$	**Calcite** $CaCO_3$
Caledonite $Pb_5Cu_2(CO_3)(SO_4)_3(OH)_6$	**Cerussite** $PbCO_3$	Chalcopyrite $CuFeS_2$
Chlorargyrite AgCl	**Chrysocolla** $(Cu,Al)_2H_2Si_2O_5(OH)_4 \cdot nH_2O$	**Copper** Cu
Conichalcite $CaCu(AsO_4) (OH)$	Corkite $PbFe_3(PO_4)(SO_4)(OH)_6$	***Cuprite*** Cu_2O
Diopside $Ca Mg Si_2O_6$	*Duftite* $Pb Cu(AsO_4)(OH)$	Goethite FeO(OH)
Galena PbS	Geochronite $Pb_{14}(Sb, As)_6 S_{23}$	*Gold* Au
Hemimorphite $Zn_4 Si_2O_7 (OH)_2 \cdot H_2O$	Leadhillite $Pb_4 (SO_4) (CO_3)_2 (OH)_2$	***Linarite*** $Pb Cu (SO_4) (OH)_2$
Malachite $Cu_2 (CO_3) (OH)$	*Mimetite* $Pb_5 (AsO_4)_3 Cl$	*Perite* $Pb BiO_2 Cl$
Pyrargyrite $Ag_3 SbS_3$	**Pyrite** $Fe S_2$	Pyromorphite $Pb_5 (PO_4)_3 Cl$
Quartz SiO_2	*Schmiederite* $Pb_2 Cu_2 (Se^{4+} O_3)(Se^{6+} O_4)(OH)_4$	Silver Ag
Sphalerite (Zn, Fe) S	Tremolite $Ca_2 (Mg, Fe)_5 Si_8O_{22} (OH)_2$	*Tsumebite* $Pb_2 Cu (PO_4) (SO_4) (OH)$
Vanadinite $Pb_5 (VO_4) Cl$	***Wulfenite*** $Pb MoO_4$	

References

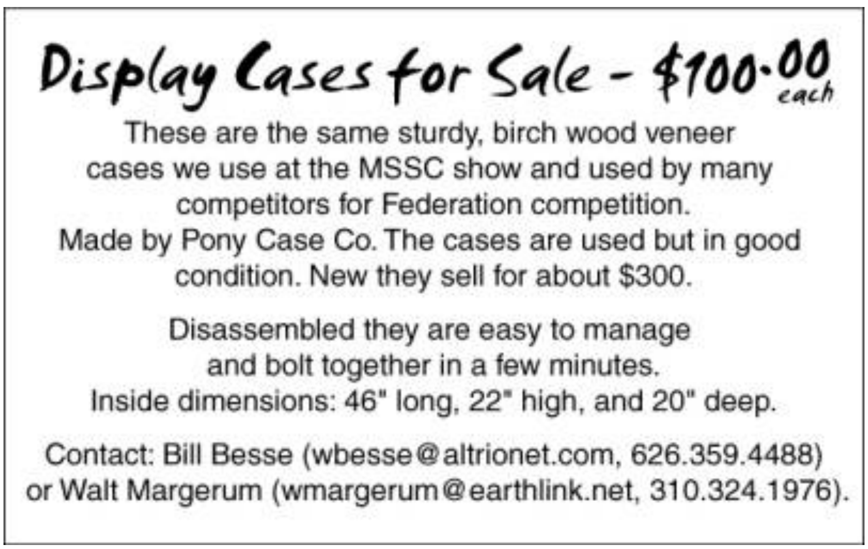
Briggs, Joel (2004), “Reward Mine and Brown Monster Group”; The Desert Drifter web site (www.desertdrifter.com/ddwebsite/articles/reward.htm).

Chalfant, W.A. (1933), “The Story of Inyo”; Chalfant Press, 430 pp.

Goodyear, W. A. (1888), “Inyo County”; California State Mining Bureau Eighth Annual Report of the State Mineralogist for the year ending October 1, 1888, pp. 262-264.

Joylon, Ralph (2005), “Reward Mine, Inyo Co., California, USA”; Mindat.org database (www.mindat.org)

Knopf, Adolph (1912), “Mineral Resources of the Inyo and White Mountains, California”; United States Geological Survey Bulletin 540, “Contributions to Economic Geology (Short Papers and Preliminary Reports) 1912, Part I. Metals and Nonmetals Except Fuels”, pp. 116-119.



2005 Calendar of Events

March 4 - 13, Imperial, Imperial Valley Gem & Mineral Society, 200 East 2nd. Street, Hours: Mon. - Fri. 4 - 10 PM; Sat. & Sun. 12 - 10 pm, Ms. Trey Handy (760) 352-2273.

March 5-6, Arcadia, Monrovia Rockhounds Inc., The Arboretum of Los Angeles County, 301 N. Baldwin Avenue, Hours: 9 - 5 both days, Jo Anna Ritchey (626) 359-1624,

March 5-6, Ventura, Ventura Gem & Mineral Society, Seaside Park (Ventura Co. Fairgrounds), 10 W. Harbor Blvd., Hours: Sat. 10 - 5; Sun. 10 – 4, Jim Brace-Thompson (805) 659-3577, Email: jbraceth@adelphia.net.

March 12-13, San Marino, Pasadena Lapidary Society, "Magic From The Earth," San Marino Masonic Center, 3130 Huntington Drive, Hours: Sat. 10 - 6; Sun. 10 – 5, Marcia Goetz (626) 914-5030, Email: joenmar1@gte.net.

April 2-3, Torrance, South Bay Lapidary & Mineral Society, "Nature's Treasures," Torrance Recreation Center, 3341 Torrance Blvd., Hours: 10 - 5 both days, Omer Goeden (818) 383-9279, E-mail: sageit@aol.com.

April 9-10, Hacienda Heights, Puente Hills Gem & Mineral Club, Steinmetz County Park Recreation Building, 1545 S. Stimson Avenue, Hours: 10 - 5 both days, Paula Hess (562) 696-2270, E-mail: rphess@adelphia.net.

April 9-10, San Diego,San Diego Mineral & Gem Society, Al Bahr Shrine Center, 5440 Kearny Mesa Rd., Hours: Sat. 9:30 - 5; Sun. 10 – 4, Wayne Moorhead (858) 586-1637.

April 22-24 Colorado Mineral and Fossil Show-Spring, Holiday Inn-Denver Central, 8449 Brannock St. & Best Western-Central Denver, 200 w. 48th Ave., Denver, CO, Fri. & Sat. 10-6, Sun. 10-5, www.mzexpos.com.

April 23-24, Bakersfield, Kern County Mineral Society, Kern County Fairgrounds, Hours: 10 - 5 both days, Nichelle Sebresos (661) 809-4705.

April 23-24, Lancaster, Antelope Valley Gem & Mineral Club, Antelope Valley Fairgrounds, 2551 West Avenue H, Hours: 9 - 5 both days, Armin Nimmer (661) 945-5769.

April 22-23 Desert Symposium, Theme: Mining History of the Eastern Mojave Desert, Desert Studies Center, Zzyzx, CA, with field trip April 24-26. Dr. William Presch, CSU Fullerton, 714-278-2215, wpresch@fulllerton.edu.

May 7-8 Anaheim, Searchers Gem & Mineral Society, Brookhurst Community Center, 2271 W. Crescent Ave., Hours: Sat. 10-5, Sun. 10-4:30.

May 7-8 Bishop, Lone Pine Gem & Mineral Society, Tri County Fairgrounds, Sierra St. & Fair Dr., Hours: Sat. 9-5, Sun 10-4, Jeff Lines 760-872-6597.

May 13-15, West Coast Gem & Mineral Show, Holiday Inn-Costa Mesa, 3131 S. Bristol St., Costa Mesa, Fri. & Sat. 10-6, Sun 10-5. www.mzexpos.com.

May 14-15 Newbury, Conejo Gem & Mineral Club *California Gems and Minerals* Borchard Park Community Center, 190 Reino Rd., Hours: Sat. 9-5, Sun. 10-5. Bob Stultz 805-498-4220.

Sept. 10-13, The weekend before the Denver Gem and Mineral Show, a mineral symposium on **"Agate and Other Forms of Cryptocrystalline Quartz"** will be held at the Colorado School of Mines campus in Golden, Colorado. The symposium will be, Sept. 10-11, with optional field trips on Sept. 12 and 13. The symposium is cosponsored by the Colorado Chapter of Friends of Mineralogy, the Colorado School of Mines Geology Museum, and the U.S. Geological Survey. It will include two days of talks on the mineralogy, origin, and worldwide occurrence of agate and other forms of cryptocrystalline quartz, a welcoming reception and tour of the Colorado School of Mines Geology Museum; a Saturday evening banquet; and information about self-guided field trips to Colorado mineral localities. Registration will be $40; Contact Friends of Mineralogy, Colorado Chapter, P.O. Box 5276, Golden CO, 80401-5276, to register or to be put on a mailing list for further information.

Science Education Center of California

Geological Exploration and Fossil Collecting Trip

11-Day vacation package

All transportation is provided

A 10-page summary of the trip can be found at www.scienceattractions.com Click on trips and vacations.

Trip#1 June 29th- July 9th

Trip#2 July 13th- July 23rd

Trip#3 July 27th – August 6th

A maximum of 15 people can be accommodated on each trip.

Trip fee: $560/person

- A $150 per person deposit is required when you make a reservation. Balance due by May 20th 2005.

Trip Details: www.scienceattractions.com

Click on trips and vacations.

Trip Highlights:

- Yellowstone and Grand Teton National Parks.
- Bryce and Zion National Parks.
- Fossil collecting at a new commercial quarry in the Green River Formation.
    - We will be spending the entire day collecting fish fossils in a limestone quarry in Wyoming.
- Kennecott Utah Copper Mine.
- Eastern Mojave National Preserve.

- Over 2,000 miles of travel through 7 states.

Contact Information: Dan Krawitz

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