WYOMING STATE GEOLOGICAL SURVEY

FIELD RECONNAISSANCE OF THE LEUCITE HILLS PERIDOT (OLIVINE) OCCURRENCE, ROCK SPRINGS UPLIFT, WYOMING

by

W. Dan Hausel
Senior Economic Geologist
Wyoming State Geological Survey
Box 3008, University Station
Laramie, Wyoming 82071

MINERAL REPORT MR98-2

1998

INTRODUCTION

During the 1997 field season, the Wyoming State Geological Survey (WSGS) continued to evaluate several areas in Wyoming for gemstones. One project initiated by the WSGS was a study of the geology and petrology of the Leucite Hills volcanic field. The Leucite Hills volcanic field consists of a group of rare volcanic rocks known as lamproites. Lamproites are extremely rare ultrapotassic igneous rocks that sometimes contain diamond (Hausel and others, 1995b).

During 1997, the Leucite Hills were mapped and sampled, and a potential source for gem-quality olivine (peridot) was discovered by the author. Because of this discovery, this preliminary report was written to provide general information on the occurrence. A more detailed report of investigations on the geology and mineralization of the Leucite Hills is currently in preparation.

Location and Accessibility

The Leucite Hills volcanic field is located in southwestern Wyoming, north of Rock Springs and Superior. The volcanic field is accessible by several graded dirt roads and jeep trails leading from the two towns (Figure 1). The Leucite Hills is a mixture of Federal, State, and private land. It is recommended that the reader contact the US Bureau of Land Management or the County Courthouse in Green River for information on the land status and ownership in the Leucite Hills.

Geology and Petrology

The Leucite Hills volcanic field consists of 22 known lamproite flows, dikes, necks, plugs, cinder cones, and pumice cones lying along the northern flank of the Late Cretaceous-Paleocene Rock Springs uplift (Hausel and others, 1995a,b). Radiometric dates indicate the Leucite Hills volcanic activity occurred between 3.1 to 1.1 Ma (Bradley, 1964; McDowell, 1966, 1971).

The Leucite Hills are formed of ultrapotassic, basic to ultrabasic, volcanic and subvolcanic rocks. Both olivine and leucite lamproites are present. Geochemically, these lavas have SiO_2 contents in the range of 42.65 to 56.34%; K_20 from 2.52 to 12.66%; and MgO from 5.8 to 12.75%.

The volcanic centers in the field consist of vesicular lavas, scoria, autolithic intrusive breccias, lapilli tuffs, tuff breccias, and agglomerates of diopside-leucite-phlogopite-lamproite, diopside-sanidine-phlogopite-lamproite, and diopside-madupitic lamproite. Vents are associated with most of the volcanic bodies, although vents are not conspicuous at South Table Mountain, North Table Mountain, Black Rock, or Hatcher Mesa. Either these vents were removed by erosion, or were buried by lavas (Ogden, 1979).

Lamproites in the Leucite Hills contain a variety of xenoliths. These include arkose, tuffaceous sandstone, argillite, siltstone, gabbro, anorthosite, and an assortment of granitic rocks. Some cognate xenoliths include lamproitic fragments of coarse-grained intergrowths of phlogopite-diopside-apatite-priderite-magnophorite with a

ocelli texture. Barton and van Bergen (1981) also reported phlogopite-chromite harzburgite, orthopyroxene amphibolite, clinopyroxene-rich pyroxenites, and mica-rich xenoliths.

Xenocrysts found in some of the lamproites include augite, barkvikitic amphibole, and orthoclase. Cognate xenocrysts include olivine with reaction rims of phlogopite, chromites with similar reaction rims, and green spinels (Carmichael, 1967).

Cross (1897) introduced three new rock names to encompass the unusual mineralogy and chemistry of these rocks. A fourth type was later proposed by Carmichael (1967) for the olivine-bearing flows at South Table Mountain and North Table Mountain *(olivine also occurs in the lamproites at Wortman dike, Endlich Hill, and Black Rock).* The four rock types include: (1) *madupite*, a diopside-rich glassy volcanic rock with poikilitic phlogopite phenocrysts enclosing diopside set in a groundmass of leucite, diopside, apatite, and glass; (2) *wyomingite*, an ultrapotassic volcanic rock with microphenocrysts of phlogopite and diopside in a groundmass of leucite, diopside, apatite, and glass; (3) *orendite*, and (4) *olivine orendite.* These latter two rock types are petrographically identical having microphenocrysts of phlogopite and diopside in a groundmass of olivine, leucite, apatite, and richterite, with considerable sanidine. Petrographically, the presence of sanidine distinguishes orendite from wyomingite.

Carmichael (1967) reported that the Wyoming madupites are distinct with no counterpart in Western Australia, and Kuehner (1980) reported that the Leucite Hills contain the only known madupites in the world. According to Carmichael (1967),*"The diagnostic texture of the madupites of phlogopite enclosing diopside, together with small crystals of magnetite and perovskite is identical to that found in the Arkansas kimberlite; olivine or its pseudomorph has never been found in a madupite, however"* (author's note: the Arkansas kimberlite described by Carmichael is now known to be a diamondiferous olivine lamproite).

At least three populations of olivines have been recognized in the Leucite Hills (Cross, 1897; Carmichael, 1967), and nearly pure forsterite olivine is found in both saturated and undersaturated rocks. The olivines include anhedral xenocrysts, and subhedral to euhedral microphenocrysts. In addition, the olivine-sanidine-phlogopite lamproites found at North Table Mountain, South Table Mountain, and Endlich Hill, have olivines that represent a third paragenesis. These consist of anhedral olivine mantled by phlogopite laths in disequilibrium with the host magma that may represent upper mantle derived xenocrysts. The olivine grains from Hatcher Mesa, are unzoned and characterized by high $Mg/(Mg+\Sigma Fe^{2+})$ and Ni. In these respects, these olivines are comparable to olivines in lherzolite and harzburgite mantle xenoliths found in kimberlite (Barton and van Bergen, 1981).

Peridot occurrence

Olivine occurs in a group of lamproites along the northeastern margin of the Leucite Hills volcanic field. Olivine has been reported at Black Rock, Endlich Hill, Hatcher Mesa, South Table Mountain, North Table Mountain, and Wortman Dike. Until petrographic and heavy mineral extraction studies are completed by the WSGS, the

quality of the olivine in some of these occurrences remains unknown. However, good-quality olivine (peridot) has been collected from the Black Rock and the North and South Table Mountain areas.

During the 1997 field season, rock samples of lamproite with one-inch long anhedral, xenocrystic, olivine grains were recovered from outcrop. The olivine is rounded, transparent, light-green, and highly fractured. Thus the size of cutable material associated with these xenocrysts is greatly diminished.

Of greater interest may be detrital sources for peridot. During field investigations, the author collected two anthills in the northeastern portion of the volcanic field that were colored green due to abundant peridot. The anthills were processed on the WSGS's Wilfley Table and approximately 13,000 carats of olivine were recovered. A significant portion of the olivine was transparent and gem in character, and dominated by light olive-green, with lesser dark-green and uncommon reddish-green mineral grains.

Because ants are restricted as to the size of material they can carry, the bulk of this material averages 3 to 4 mm in diameter, with a maximum size of 8 mm (about 1/4 inch) in length. However, the adjacent soils have not been sampled, to date, and they potentially could contain abundant peridot as well as grains too large for the ants to sample.

CONCLUSIONS

In conclusion, some lamproites in the northeastern portion of the Leucite Hills contain peridot, a gem variety of olivine. Soils near some of these lamproites appear to be rich in olivine, and potentially could provide minor sources of cutable peridot. The presence of undiscovered olivine lamproites in this region must also be considered, as olivine-rich lamproites tend to erode rapidly, particularly where the olivine has been serpentinized.

REFERENCES CITED

Barton, M., and van Bergen, M.J., 1981, Green clinopyroxenes and associated phases in a potassium-rich lava from the Leucite Hills, Wyoming: Contributions to Mineralogy and Petrology, v. 77, p. 101-114.

Bradley, W.H., 1964, Lazurite, talc and chlorite in the Green River Formation of Wyoming: The American Mineralogist, v. 49, p. 778-781.

Carmichael, I.S.E., 1967, The mineralogy and petrology of the volcanic rocks from the Leucite Hills, Wyoming: Contributions to Mineralogy and Petrology 15, p. 24-66.

Cross, W., 1897, Igneous rocks of the Leucite Hills and Pilot Butte, Wyoming: American Journal of Science, v. 4 no. 20, p. 115-141.

Hausel, W.D., Love, C.M., and Sutherland, W.M., 1995a, Road log - Leucite Hills, Green River Basin, Wyoming *in* R.W. Jones and Gary A. Winter (editors), Wyoming Geological Association Guidebook, Resources of Southwestern Wyoming, p. 137-151.

Hausel, W.D., Sutherland, W.M., and Gregory, R.W., 1995b, Lamproites, diamond indicator minerals, and related anomalies in the Green River Basin, Wyoming *in* R.W. Jones (editor), Wyoming Geological Association 1995 Field Conference Road Logs, Resources of Southwestern Wyoming, p. 45-53.

Kuehner, S.M., 1980, Petrogenesis of ultrapotassic rocks, Leucite Hills, Wyoming: M.S. thesis, University of Western Ontario, London, Ontario, 197 p.

McDowell, F.W., 1966, K-Ar dating of cordilleran intrusives: PhD dissertation, Columbia University, New York, 97 p.

McDowell, F.W., 1971, K-Ar ages of igneous rocks from the western United States: Isochron/west, no. 2, p. 1-16.

Ogden, P.R., Jr., 1979, The geology, major element geochemistry, and petrogenesis of the Leucite Hills volcanic rocks, Wyoming: PhD dissertation, University of Wyoming, Laramie, 137 p.

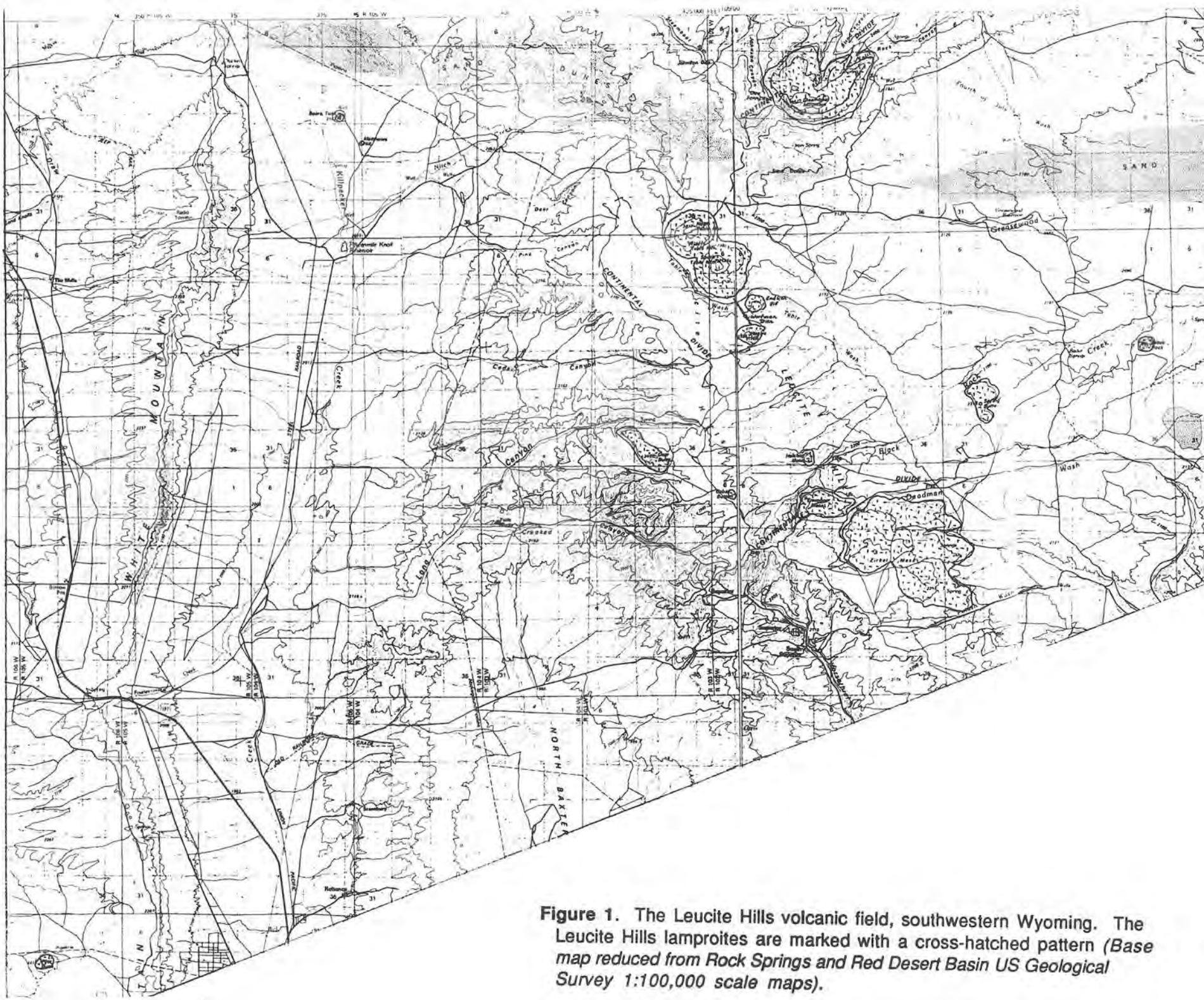

Figure 1. The Leucite Hills volcanic field, southwestern Wyoming. The Leucite Hills lamproites are marked with a cross-hatched pattern *(Base map reduced from Rock Springs and Red Desert Basin US Geological Survey 1:100,000 scale maps).*