GEOCHEMICAL AND MORPHOLOGICAL EVALUATION OF INDICATOR MINERAL ANOMALIES IN NORTHEASTERN UTAH AND SOUTHWESTERN WYOMING, USA

W. P. Nash[1], T. E. McCandless[2,3]

1. Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84110 USA
2. Department of Geological Sciences, University of Cape Town, Cape Town, South Africa
3. Present address: Department of Geosciences, University of Arizona, Tucson, Arizona USA 85721

Minerals of upper mantle origin occur in conglomerates, pediments and on antmounds in the southern Green River Basin. Chrome-bearing pyrope, pyrope-almandine, diopside, spinel and pircoilmenite 6 mm in size are found on antmounds with similar minerals as large as 12 mm in diameter in the Bishop Conglomerate. These minerals are part of the kimberlite indicator mineral suite, because their presence in secondary environments commonly indicates a nearby kimberlitic source (Gurney et al., 1993).

The Green River Basin is a broad structural depression located in southwestern Wyoming, filled with Tertiary lacustrine and fluvial deposits. The Uinta Mountains in Utah form the southern boundary, and are an east-west anticline with tilted Paleozoic and Mesozoic rocks flanking a core of flat-lying Proterozoic (1.6-0.9 Ga) metasediments and Archean (2.7 Ga) gneisses. A rancher in the area found 'rubies' on anthills in the southern Green River Basin that were later identified as pyrope garnet and chrome diopside (McCandless; 1982). Extensive sampling established that the minerals are eroded from the 29 Myr. old Bishop Conglomerate, which is in turn derived from Uinta Mountains. Indicator-bearing streams were subsequently located in the Uinta Mountains.

The garnets fit into group 9 of Dawson and Stephens (1975), consisting of garnets from kimberlite and from garnet-bearing lherzolite, websterite, and harzburgite, and into group 3 or 6, derived from eclogites (Dawson and Stephens, 1975). Chrome diopsides and omphacitic diopsides correspond to lherzolite and websterite (Dawson and Smith, 1977; Emeleus and Andrews, 1975; Nixon and Boyd, 1973), and salitic diopsides are similar to pyroxenes from mica-amphibole-rutile-ilmenite-diopside (MARID) suite xenoliths (Waters, 1987), or to clinopyroxene megacrysts from the Hatcher Mesa lamproite in the Leucite Hills, Wyoming (Barton and van Bergren, 1981; McCandless, unpublished data). This latter grouping is not reported from kimberlite, and may represent a new indicator mineral in the exploration for lamproites (McCandless and Nash, 1995).

None of the pyropes from the Green River Basin or Uinta Mountains have G10 chemistry. Elevated levels of Na_2O in eclogitic garnet (>0.07%) indicative of diamond-bearing eclogite (Sobolev, 1974; McCandless and Gurney, 1988), were not detected in the eclogitic garnets, and preclude an eclogitic diamond potential. None of the chromites from this study have MgO and Cr_2O_3 similar to those from diamond inclusions. A few ilmenites with moderate Cr_2O_3 and MgO represent less than ten percent of all ilmenites analyzed and lie outside the area for ilmenites associated with diamondiferous diatremes. Finally, the estimated temperatures for garnet/clinopyroxene intergrowths are well outside the diamond stability field (40-80 km) and indicate that the potential for diamonds in the host rocks of these minerals is very low (McCandless and Nash, 1995).

Evaluating the diamond potential of detrital minerals has built into it the assumption that the detrital suite is representative of the primary host rock from which it is derived. This assumption is confirmed with some certainty in areas of continental glaciation (Krajick, 1994; Gurney, 1995) and in arid areas where movement of indicators has not been far from the igneous host (Gurney et al., 1993) The assumption remains to be tested in areas where temperate climate and multiple cycles of fluvial transport dominate, such as in the Green River Basin. Therefore, an igneous host must be located and tested for diamond cogenetic minerals before it can be established with certainty that diamonds are not present in the Green River Basin.

The Bishop Conglomerate is poorly-sorted, with boulders several meters in diameter in the coarser layers. Indicator minerals are in both the coarse and fine layers of the conglomerate, with diopside up to 12 mm in diameter in the coarser layers. The Bishop Conglomerate can contain over 50% clay-sized particles, which has been shown experimentally to inhibit mineral wear in high energy fluvial systems (McCandless, 1990). Thus, the occurrence of 12 mm diameter omphacitic diopside in the Bishop Conglomerate does not necessarily infer a short transport distance.

Peridotite and lamproite occur in the western Uintas, with ages from 11.7 to 40.4 Myr. (Best et al., 1968; Best, pers. commun. 1987), and could have shed detrital minerals into the Green River Basin during the late Oligocene or early Miocene when transport directions in this area were to the northeast. However, indicator minerals have not been recovered from these localities. Indicator minerals were not recovered in the Uintas upstream of the Bishop Conglomerate occurrences, despite concentrated sampling in this region. A continuous mineral train may have been severed by the east flowing Henrys Fork River, which established its course in the late Pliocene. Locating source rocks in the immediate vicinity of the Uinta anomalies is also complicated by extensive glaciation of the western and central Uinta Mountains in the Pleistocene, which may have eroded sources such that only a few minerals are shed into streams.

A final complication in the search for the igneous host of Green River Basin minerals is the Great Diamond Hoax of 1872. In 1871 and 1872, an area in the northeast Uinta Mountains was salted with diamonds and assorted gemstones. The fraud was subsequently exposed by government geologists, spurred on by the finding of a partly faceted diamond in the area. Diamonds, ruby, and pyrope garnet can be found on the surface of a sandstone outcrop below 'Diamond Peak', which is capped by the Bishop Conglomerate containing indicator minerals. Salting with rubies in the original hoax is documented in history, as is the purchase of 50 lbs. of pyrope garnet from native Americans in northeastern Arizona. Samples collected from antmounds in the hoax area produced two diamonds and several rubies and garnets, but no clinopyroxenes were recovered. In contrast, the Bishop Conglomerate at Diamond Peak contains chrome and omphacitic diopsides, but no garnets were recovered. This provides some evidence that the area was the hoax locality and not a natural occurrence of detrital diamond. Until a *bona fide* igneous host can be located, this unusual association should not be totally dismissed.

REFERENCES

Barton, M. and van Bergren, M.J. (1981) Green cliopyroxenes in a potassium-rich lava from the Leucite Hills, Wyoming. Contributions to Mineralogy and Petrology, 77, 101-114.

Best, M.G., Henage, L.F. and Adams, J.A.S. (1968) Mica peridotite, Wyomingite, and associated potassic igneous rocks in northeastern Utah. American Mineralogist, 53, 1041-1048.

Dawson, J.B. and Stephens, W.E. (1975) Statistical classification of garnets from kimberlite and associated xenoliths. Journal of Geology, 83, 589-607.

Emeleus, C.H. and Andrews, J.R. (1975) Mineralogy and petrology of kimberlite dyke and sheet intrusions and included peridotite xenoliths from southwest Greenland. Physics and Chemistry of the Earth, v.9, p.179-197.

Gurney, J.J., Helmstaedt, H.H. and Moore, R.O., (1993) A review of the use and application of mantle mineral geochemistry in diamond exploration. Pure and Applied Chemistry, v.65, p.2423-2442.

Gurney, J.J., (1995) Diamond discovery in the North West Territories of Canada. Exploration and Mining Geology, v.4, p.86.

Krajick, K. , (1994) The great Canadian diamond rush. Discover, December, p.70-79.

McCandless, T.E. (1982) The mineralogy, morphology, and chemistry of detrital minerals of a kimberlitic and eclogitic nature, Green River Basin, Wyoming. Unpublished M.S. Thesis, University of Utah, 107p.

McCandless, T.E. (1990) Kimberlite xenocryst wear in high energy fluvial systems. experimental studies. Journal of Geochemical Exploration, 37, 323-331.

McCandless, T.E. and Gurney, J.J. (1989) Sodium in garnet and potassium in clinopyroxene. criteria for classifying mantle eclogites. In. J.M Ross , editor, Kimberlites and Related Rocks: v.2, their Mantle/Crust Setting, Diamonds, and Diamond Exploration. Geological Society of Australia Special Publication No. 14, p.827-832. Blackwell Scientific, Victoria, Australia.

McCandless, T.E. and Nash, W.P., (1995) Evaluation of kimberlitic indicator minerals with respect to igneous host, mantle conditions and diamond potential, southwestern Wyoming and northeastern Utah, USA. Exploration and Mining Geology, in press.

Mosig, R.W. (1980) Morphology of indicator minerals as a guide to proximity of source. Geology Department and University Extension, University of Western Australia, 5, 81-88.

Nixon, P.H. and Boyd, F.R. (1973) Petrogenesis of the granular and sheared ultrabasic nodule suite in kimberlite. In: Nixon, P.H. (Editor), Lesotho Kimberlites. Lesotho National Development Corporation, Lesotho. pp.48-56.

Sobolev, N.V. (1974) Deep-seated Inclusions in Kimberlites and the Problem of the Composition of the Upper Mantle. American Geophysical Union. Washington, D.C. 279p.

Stephens, W.E. and Dawson, J.B. (1977) Statistical comparison between pyroxenes from kimberlites and their associated xenoliths. Journal of Geology, 85, 433-449.

Waters, F.G. 1987b. A suggested origin of MARID xenoliths in kimberlites by high pressure crystallization of an ultrapotassic rock such as lamproite. Contributions to Mineralogy and Petrology, 95, 523-533.