GEOCHEMISTRY AND MINERALOGY OF THE LEMHI PASS REE-Th DEPOSITS: AN EXAMPLE OF REE-TH MOBILITY. P. E. Gibson, S. A. Wood and L. Lang, Department of Geology, University of Idaho, Moscow, ID 83843-3022 (208) 885-5966

The Lemhi Pass REE-Th deposits sits astride the continental divide partially in Beaverhead County, Montana and, partially in Lemhi County, Idaho. Mineralization occurs in veins with potassic alteration halos and replacement textures are observed in the veins, suggesting hydrothermal activity. REE-Th minerals consists primarily of thorianite ($Th_{0-0.80}$ $U_{0-0.04}REE_{0-.12}$ $Al_{0-0.26}Si_{0-1.00}P_{0-0.51}O_4$), monazite ($Th_{0-0.107}REE_{0.76-0.95}Ca_{0-0.06}P_{0.95-1.05}O_4$), xenotime ((Y, REE)$PO_4$) and allanite ((REE,Ca,Y)$_2$(Al,Fe^{3+})$_3$(SiO_4)$_4$(OH)), with monazite hosting much of the REE. Xenotime and allanite compositions have only been determined qualitatively thus far. Substitution of Si^{4+} for P^{5+} seems to be an important process in monazite and thorite and is expected to play an important role in xenotime as well (e.g., $Th^{4+} + Si^{4+} \leftrightarrow REE^{3+} + P^{5+}$). Gangue minerals consist of K-feldspar, quartz and Fe-oxides. It is interesting that allanite has been identified in only one vein (Lucky Horseshoe) in the area, and tends to be associated with the monazite. This vein differs from other veins with respect to the presence and foliation of sheet silicates (chlorite, biotite, muscovite) as gangue. A carbonatite is also present in the field and it consists primarily of coarse calcite, dolomite, apatite and magnetite with accessory barite

Geochemical analyses have been carried out on both the carbonatite and the veins in order to: 1) determine the relationship of the carbonatite to the mineralization in the veins; 2) determine the nature of the fluid(s) responsible for the mobility of the REE's and Th; and 3) determine the reasons for the presence of allanite in the Lucky Horseshoe vein and its absence elsewhere. REE-Th minerals are closely associated on a microscopic scale with Fe-oxides in both the carbonatite and the veins. Chondrite-normalized REE plots for the veins show MREE-enrichment while the carbonatite shows LREE-enrichment. This result throws doubt on a direct relationship of the Lemhi Pass mineralization to carbonatite activity. Microprobe analyses indicate that the monazite and thorite in the veins are MREE-enriched (thorite is an order of magnitude less abundant), whereas the monazite from the carbonatite is LREE-enriched. However, the monazite and the thorite cannot account for the total REE from the whole rock analyses. Therefore, some REE's may be associated with the Fe-oxides, or other REE-bearing minerals. Qualitative SEM analyses show xenotime to be depleted in the LREE with respect to the MREE and HREE. Xenotime is currently being analyzed quantitatively for its REE content and its presence may solve the mass balance problem for the REE's. Apatite contributes negligible amounts of REE. To quantify the mobility of the REE and Th, a mass transfer study of an alteration halo from one vein (Lucky Horseshoe) is being conducted. This study may also aid in determining why allanite is present at the Lucky Horseshoe Deposit. Isotope and fluid inclusion studies are also being conducted in order to corroborate the current findings and give us a further understanding of these deposits. These geochemical data will be used to construct a model for the origin of these deposits and give us a better understanding of the mobility of the REE and Th. Our study of the Lemhi Pass deposits should further aid in understanding the formation of other hydrothermal REE deposits around the world and may provide information relevant to performance assessment of deeply buried nuclear waste repositories.