APPENDIX 8. ELECTRON MICROPROBE LAB ANALYSIS REPORT, APACHE MESA, RIO ARRIBA COUNTY, NEW MEXICO

Analyses: Rock samples in 1-inch rounds

Date: Dec. 28, 2015

Analysts: A. Robison, N. Dunbar

Objective of analyses

To assess the distribution of minerals and chemical elements in samples, to determine the composition of rare earth phases.

Summary of Data for each sample

The majority of the samples (all but the two VA samples) are detrital sandstones composed mostly of quartz and some lithics. Alteration of grains (mostly in quartz grains) and weathering appears in these samples, though the intensity ranges. Cementation is composed mostly of Fe oxide and some silica. The VA samples are unconsolidated sand. Qualitative analyses were performed on all samples, and chemical analyses on those containing rare earth minerals. Chemical formulas for all minerals found are as follows:

- Albite: $NaAlSi_3O_8$
- Chromite: $FeCr_2O_4$
- Ilmenite: $FeTiO_3$
- Monazite: (Ce, La, Th) PO_4
- Orthoclase: $KAlSi_3O_8$
- Quartz: SiO_2
- Rutile: TiO_2
- Xenotime: YPO_4
- Zircon: $ZrSiO_4$

DH 3-1. The sample is well cemented, with most grains not touching each other. The cement is heavily composed of silica and some Fe oxide. The minerals present, in order of most to least abundance, are quartz, zircon, monazite, and xenotime. Quartz makes up well over 50% of the mineral grains. These grains are oblong and rounded and somewhat altered. The zircon grains are very fractured and blocky. Few monazite grains were found, and only one xenotime grain.

DH 7-1. The sample is somewhat porous and less cemented, but many of the grains are touching. The cement is more heavily composed of Fe oxide than of silica. The minerals present are quartz

and zircon. Quartz makes up over 80% of the sample. These grains are oblong and subangular and somewhat altered. The zircon grains are more rounded than in DH 3, and not as fractured.

SAN 6. The sample is porous but well cemented. Grains are bunched together and touching, forming masses within the Fe oxide cement. Minerals present are quartz, ilmenite, zircon, and monazite. Some of the ilmenite grains are zoned, containing more Fe in the centers or having edges contaminated with silica. The ilmenite grains have up to the third order of Ti. Most monazite grains are zoned, being higher in Ce on the edges.

SL 14. The grains in the sample are mostly supported by Fe oxide cement and some silica cement. The minerals present are quartz, albite, and zircon. The quartz grains are oblong and subrounded and make up nearly all of the grains present in the sample. The albite grains are blockier and less altered than the quartz. The zircon grains are very small compared to the other grains, and less fractured.

SL 16. The grains in the sample are mostly supported by Fe oxide cement and some silica cement. The minerals present are quartz, zircon, albite, rutile, orthoclase, and chromite. The zircon grains, which are abundant compart to previous samples, are rounded and less fractured or altered than the quartz grains. Crystal surfaces can be seen in the rutile grains, which are very small but abundant and can almost be mistaken as Fe oxide cement. There is only a single chromite grain found. It is approximately the same size and shape as the zircon grains.

SL 20. The sample is well cemented and not very porous. There are more grains touching than not. The cement is mostly Fe oxide with some silica. The minerals present are quartz, albite, orthoclase, and a clay mineral which may be illite. Most grains are heavily altered. There is also an inclusion found in a quartz grain that is composed of Cu and Zn. This could be the mineral azurite.

SL 28. The sample is well cemented and not very porous. Very few grains are touching and are mostly supported by Fe oxide cement and some silica cement. The minerals present are quartz, zircon, albite, ilmenite, rutile, monazite, and xenotime. The zircon grains are relatively abundant. Some of the less altered zircon grains are more fractured and obvisouly zoned. There are only a few rutile grains, and even fewer monazite grains. There is only a single grain of xenotime found. Also discovered are silver inclusions in a very small grain composed of some percentages of the elements Dy, Er, and Gd.

VA 3. A heavy, black, unconsolidated, finely sorted sand. The grains are relatively all the same

shape and size. The minerals present are ilmenite, zircon, monazite, and quartz. Though the sand is mainly composed of ilmenite, there is a relatively large abundance of zircon and even monazite, which both outnumber the quartz grains. Most monazite grains are zoned, some with a lower Ce percentage and a higher La percentage than others. Most of these grains have a higher Ce count around their edges.

VA 7-15. An unconsolidated sand that is much more weathered than VA 3. The minerals present are quartz, ilmenite, and zircon. The quartz grains are the largest, most altered, and can greatly very in size and shape. The ilmenite and zircon grains are more similar in size and shape (rounded). There is a small inclusion in an ilmenite grain composed of the element Zr. It is not zircon, however, since there is no silica present. It is most likely the mineral beddeleyite (ZrO_2).