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# Supplemental Material

**Table S1.** Petrographic Information for All Samples Analyzed.

**Supplemental Text.** Documentation of blue rutile in samples.

**Figure S1.** Examples of the blue-type rutile found in sample 286. Panel B is looking down the c-axis.

**Figure S2.** Nb concentration in rutile grains measured via EPMA and sorted by perceived color.

**Figure S3.** All zircon U-Pb data collected having <15% uncertainty.

**Figure S4.** Composition of garnet grains by sample. Dots are averages for individual samples and encompass uncertainties in analyses.

**Supplemental Data.** LASS, EPMA, and XRF data.

**Table 1. PETROGRAPHIC INFORMATION FOR ALL SAMPLES ANALYZED**

| Sample | Major Phases | Accessory Phases | Notes |
|---|---|---|---|
| 18KH1 (K) | gt (20%), q (40%), sil (20%), kfs (15%), pl (<5%) | rt, ap, zrn, mnz, ilm, oxides | Gts mostly unaltered; one of samples in best shape |
| 18KH9 (K) | gt (20%), q (45%), sil (20%), kfs (15%) | rt, ap, zrn, mnz, ilm, oxides | Relatively inclusion-free gts |
| 18KH10 (K) | gt (15%), q (50%), sil (15%), kfs (20%), pl (1%) | rt, ap, zrn, mnz, ilm, sulfides | Gts small (~2mm); intact gt cores; perthitic kfs |
| 117848-125 (K) | gt (20%), q (40%), sil (15%), kfs (20%), pl (<5%) | rRt, ap, mnz, zrn, oxides, sulfides | Only rims of gt altered |
| 117848-136A (K) | gt (25%), q (40%), sil (5%), kfs (20%), pl (4%), bio (1%) | rt, bio, zrn, oxides, pyx, melt | Gts heavily altered; perthitic kfs; symplectites; only sample with biotite (intermingled with pyx and melt?); bio and pyx possibly secondary |
| 117848-286 (P) | gt (30%), q (20%) sil (45%), kfs (5%) | rt, zrn, mnz, ilm, sulfides | Gts mostly altered; blue rutile |
| 117848-309 (K) | gt (15%), q (45%), sil (10%), kfs (15%), pl (10%) | rt, ap, mnz, zrn, ilm, oxides, sulfides | More pl than typical; lots of large relatively intact gt cores |
| | | | |

** K = Kilbourne Hole, P = Potrillo Maar. Ap = apatite, bio = biotite, gt = garnet, ilm = ilmenite, kfs = potassium feldspar, mnz = monazite, pl = plagioclase, pyx = pyroxene q = quartz, rt = rutile, sil = sillimanite, zrn = zircon*

## II. BLUE RUTILE

Blue rutile was discovered in four of the metapelite samples (Fig. S1), two of which also have typical brown rutile. Both varieties of rutile were analyzed using the Cameca SX-100 electron microprobe (EPMA) at UCSB to determine whether any unusual chemistry could explain the blue color. Magnesium, Al, Si, Fe, Ti, Zr, V, Cr, Nb, Ta were all analyzed.

Rutile have variable Nb contents. The blue grains contain as much as 1.1 wt% Nb, whereas the brown grains all have less than 0.5 wt%. There is also some variation among the blue rutile. The mean and standard deviation of Nb content of the pure blue (e.g., left grain in Fig. 13) is 4990 ± 2320 ppm and ranges from approximately 2100 to 11,000 ppm. However, including all of the blue-type rutile (blue, purple, green, gray), the average Nb content is 4190 ± 2280 ppm. Though there appears to be a difference between the pure blue and other blue-type

**Blue-type Rutile**

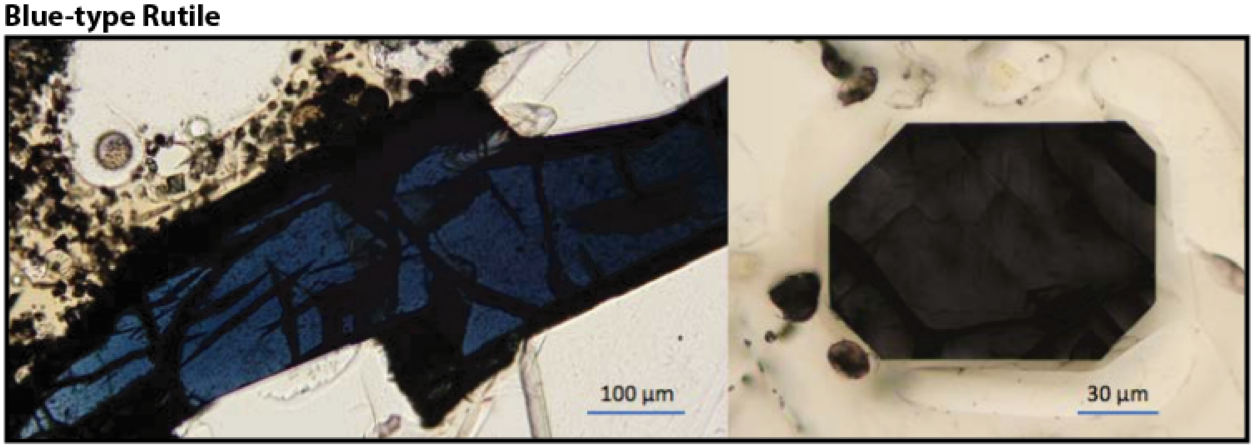


*Figure S1. Examples of the blue-type rutile found in sample 286. Panel B is looking down the c-axis.*

(e.g., green, purple, etc.) rutile, it is also possible that this is a coincidence and that the color difference is only the result of optic axis orientation. By applying an unpaired t-test to this limited set of data, it was determined that these two populations are not statistically different.

Whereas the brown rutile has an average Nb concentration of 3550 ± 1000 ppm and a maximum measured Nb concentration of < 500 ppm, it is clear that the blue-type rutile can contain significantly more Nb (Fig. S2). However, it is probable that the blue color is not due to the presence of additional Nb. Rather, the two are likely the result of the same thing: the presence of $Ti^{3+}$ in the rutile crystal lattice. While there is only one other documented occurrence of natural terrestrial blue rutile (Mposkos and Kostopoulos, 2001), there are multiple instances of synthetic blue rutile containing $Ti^{3+}$ documented in the materials science literature (e.g., Khomenko et al., 1998). If $Ti^{3+}$ is the cause of the blue color in these rutile, it would be possible to explain the high Nb content by a coupled substitution of $Nb^{5+}$ and $Ti^{3+}$ for $2Ti^{4+}$.

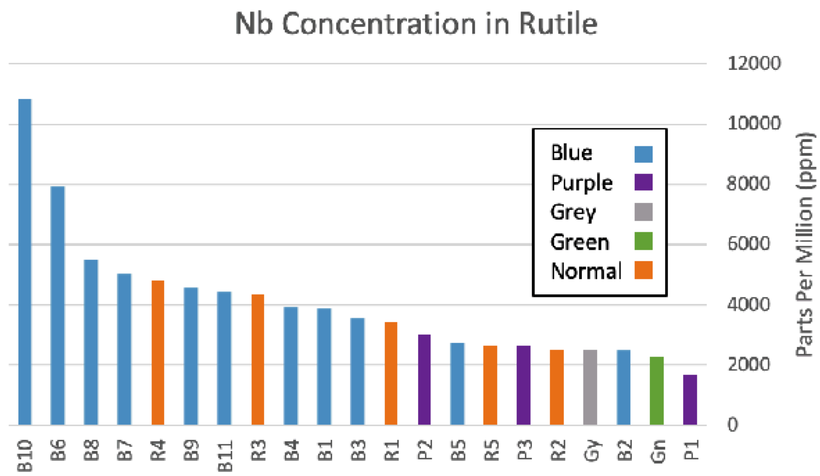

*Figure S2. Nb concentration in rutile grains measured via EPMA and sorted by perceived color.*

**III. ALL ZIRCON DATA**

All zircon data collected from the four samples (both detrital and metamorphic) are shown in Fig. S3.

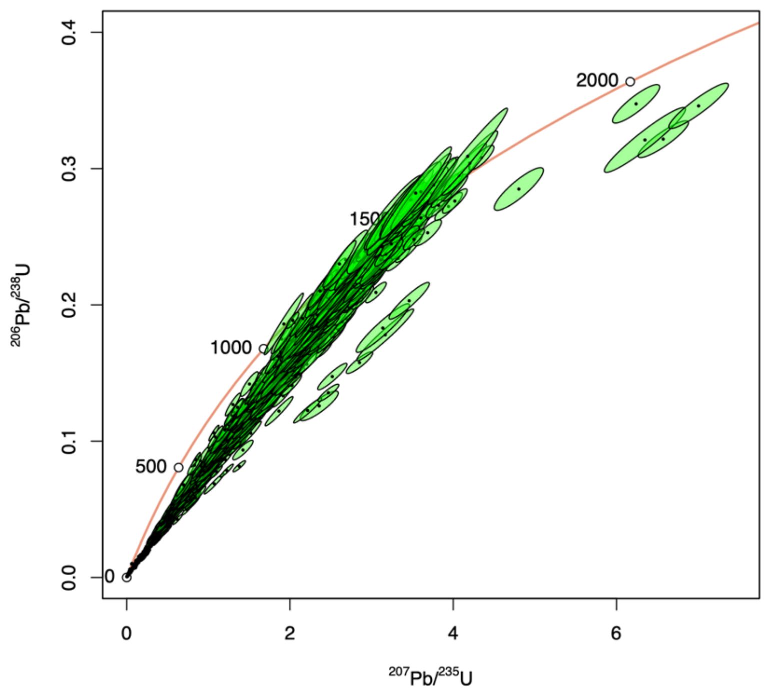

*Figure S3. All zircon U-Pb data collected having <15% uncertainty.*

## IV. GARNET COMPOSITIONS

Samples in supplementary tables have been plotted herein to show composition (Alm-Py-Grs content).

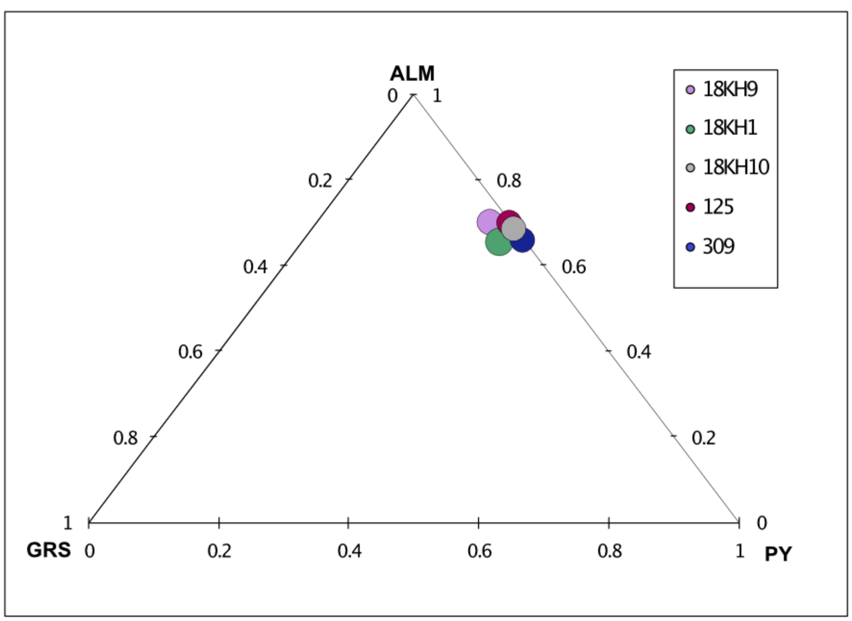

*Figure S4. Composition of garnet grains by sample. Dots are averages for individual samples and encompass uncertainty Samples. 125 and 309 are SI samples with the prefix 117848.*

## V. REFERENCES

Khomenko, V.M., Langer, K., Rager, H., and Fett, A., 1998, Electronic absorption by Ti 3 + ions and electron delocalization in synthetic blue rutile: Physics and Chemistry of Minerals, v. 25, p. 338–346.

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