**Table.1 Detection limits for major and trace elements of the PANalytical PW2400 Sequential WDXRF Spectrometer.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Major oxides** | **Limits of Detection (ppm)** | **Trace element** | **Limits of detection (ppm)** |
| SiO2 | 60 | As | 2.5 |
| TiO2 | 57 | Ba | 8.0 |
| Al2O3 | 59 | Cd | 15.4 |
| Fe2O3 | 43 | Co | 2.9 |
| MgO | 53 | Cr | 2.9 |
| CaO | 45 | Cu | 2.0 |
| Mn3O4 | 35 | Ga | 1.0 |
| Na2O | 60 | Mo | 1.8 |
| K2O | 39 | Nb | 1.0 |
| P2O5 | 27 | Ni | 2.0 |
| SO3 | 55 | Pb | 2.0 |
| Cr2O3 | 31 | Rb | 1.0 |
| NiO | 15 | Sb | 2.9 |
|  |  | Sn | 3.9 |
|  |  | Sr | 0.9 |
|  |  | Th | 2.8 |
|  |  | U | 2.9 |
|  |  | V | 2.9 |
|  |  | Y | 1.0 |
|  |  | Zn | 1.8 |
|  |  | Zr | 1.0 |

**Table.2 Detection limit of Agilent 7700x ICP-MS used for trace element analysis.**



**Table.3 Analytical setting for EMPA analyses**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Corundum** |  |  |  |  |  |  |
| **Channel** | **Crystal** | **Element/Line** | **Standards(s)** | **Peak Pos (mm)** | **Background (-)** | **Background (+)** |
| 1 | TAP | F | Flureite | 199.287 | -7 | 6 |
|  |  | Na | Albite | 129.446 |  |  |
|  |  | Mg | Periclase | 107.493 | -9 | 6 |
|  |  | Al | Al2O3 synthetic/albite | 90.646 |  |  |
|  |  | Si | Various | 77.45 | -3 | 3.5 |
| 2 | PET | K | Sanidine | 120.101 |  |  |
|  |  | Ca | Diopside | 107.931 |  |  |
| 3 | LIF | Ti | Rutile/TiO2 | 191.371 | -6 | 8 |
|  |  | Ba | Benitoite/barite | 193.177/193.150 | -6 | 6 |
| 4 | LIF | Mn | Rhodonite | 146.343 |  |  |
|  |  | Fe | Haematite | 134.834 |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Amphiboles** |  |  |  |  |  |  |
| **Channel** | **Crystal** | **Element/Line** | **Standards(s)** | **Peak Pos (mm)** | **Background (-)** | **Background (+)** |
| 1 | TAP | F | Flureite | 199.287 | -7 | 6 |
|  |  | Na | Albite | 129.446 |  |  |
|  |  | Mg | Periclase | 107.493 | -9 | 6 |
|  |  | Al | Al2O3 synthetic/albite | 90.646 |  |  |
|  |  | Si | Various | 77.45 | -3 | 3.5 |
| 2 | PET | K | Sanidine | 120.101 |  |  |
|  |  | Ca | Diopside | 107.931 |  |  |
| 3 | LIF | Ti | Rutile/TiO2 | 191.371 | -6 | 8 |
|  |  | Ba | Benitoite/barite | 193.177/193.150 | -6 | 6 |
| 4 | LIF | Mn | Rhodonite | 146.343 |  |  |
|  |  | Fe | Haematite | 134.834 |  |  |

**Table.4 Samples and methods**

Samples are labelled based on their collection point and all denoted with PAR (Paranesti) prefix. Prior to any analysis, the selected samples were firstly processed into a fine powder (≤ 25 µm grain size). Rock crushing and milling were conducted at the School of Biological, Earth and Environmental Sciences (BEES), UNSW using a combination of a jaw crusher, geological pick and brass plate, and the *Rocklabs* Tungsten ring mill. Prior to milling, samples were broken into small (< 10 mm) pieces using either the rock jaw crusher or geological pick and brass plate, then any remaining weathered and oxidised surfaces were removed to ensure that only fresh and unweathered rocks were processed for analysis.

For XRF analysis, glass beads and pressed pellets in aluminium caps were prepared for major and trace elements, respectively. Both trace and major elements were analysed using the PANalytical PW2400 Sequential WDXRF Spectrometer that had been calibrated using certified reference materials.

The microscope was operated under high-vacuum conditions with an accelerating voltage of 20 kV and beam current of 3 nA at working distances from 12.5 mm. SEM images were acquired to highlight topography and surface damage of the samples. The column of the instrument employed for the analysis was surrounded by 4 wavelength dispersive spectrometers (WDS) to detect and measure the X-ray emitted for semi-quantitative analysis of the samples.

The quality of the EMPA results was monitored via analysis of additional mineral and synthetic standards of known composition. The standards used were Ga (GaAs), Na (albite), Mg (periclase), Al (MP1 garnet), Si and Mn (Rhodonite), P (apatite), Nb (Nb+Sn metal), K (sanidine), Ca (diopside), Ti (rutile), Cr (chromite), Fe (hematite), Ta (Ta metal), F (fluorite), and Ba (benitoite). Grains analysed included the rubies, spinel inclusions within the rubies, phyllosilicates rimming the rubies, surrounding amphiboles and chlorite from the chlorite zone.

For the ICP-MS analyses, 100 mg of the samples were digested with HF-HNO3 mixtures in high pressure bombs in an oven at 180 degrees Celsius for 60 hours. Solutions were then evaporated to dryness then redissolved in HCl for 24 hours in the oven. Next, samples were dried down and refluxed twice with conc. HNO3, then dissolved in sealed vessels with 3N HNO3 overnight. Solutions were transferred to transparent polycarbonate tubes, diluted with water and centrifuged, then inspected for undissolved fluorides. If present, the supenatants are transferred to new tubes for those samples containing fluorides, and the fluorides transferred to bombs and dissolved in HCl overnight in the oven. These solutions were then dried down, refluxed with nitric, then dissolved in 3N HNO3. These solutions were re-combined with their corresponding supernatant solutions and centrifuged to ensure no fluorides remained. An aliquot of the solution is further diluted with a 1.8% HNO3 solution containing an internal standard mixture to give a total dilution factor of 13000. Analytical and drift correction procedures are comprehensively described in Eggins et al. (1997). The method uses a natural rock standard for calibration, internal drift correction using multi-internal standards (Li6, Sr84, Rh, Sm147, Re and U235), external drift monitors and aggressive washout procedures. Differences from the Eggins et al. (1997) method are: 1) Tm, In and Bi were not used as internal standards as they are measured as analytes; (2) Two digestions of the USGS standard W-2 are used for instrument calibration. The preferred concentrations used for W-2 were mostly derived by analysing it against synthetic standards and a literature survey of isotope dilution analyses (Kamber et al., 2003, 2005). Because only a single calibration standard is used, data can be easily normalised to other sets of preferred values for standards.

The samples for ICP-MS were analysed at the School of Earth Sciences, University of Melbourne on an Agilent 7700x. The instrument was tuned to give Cerium oxide levels of < 1%. 4 replicates of 100 scans per replicate were measured for each isotope. Dwell times were 10 milliseconds, except for Be, Cd, In, Sb, Ta, W, Tl, Bi, which were 30 milliseconds. Long sample wash-out times of 6 minutes with solutions of 0.5% Triton X-100, 0.025% HF in 5% HNO3 and 2% HNO3 and long sample uptake times of 120 seconds were used. Digests of USGS andesite standard AGV-2 and USGS basalt standard BHVO-2 were run as unknowns.

Eggins S. M., Woodhead J. D., Kinsley L. P. J., Mortimer G. E., Sylvester P., McCulloch M. T., Hergt J. M. and Handler M. R. (1997) A simple method for the precise determination of >=40 trace elements in geological samples by ICPMS using enriched isotope internal standardisation. Chem. Geol. 134, 311–326.

Kamber B. S., Greig A., Schoenberg R. and Collerson K. D. (2003) A refined solution to Earth’s hidden niobium: implications for evolution of continental crust and mode of core formation. Precambrian Res. 126, 289–308.

Kamber B. S., Greig A. and Collerson K. D. (2005) A new estimate for the composition of weathered young upper continental crust from alluvial sediments, Queensland, Australia. Geochim. Cosmochim. Acta 69, 1041–1058.

**Table.5 Paranesti mineral assemblages (modal amounts determined using quantitative XRD)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Mineral** | **PAR-1 (corundum-bearing)** | **PAR-5 (corundum-bearing)** | **Non-corundum bearing**  |
| Pargasite | 67.6% - 89.7% | 47.1% - 78.5% | 64.6% - 78.5% |
| Corundum | 4.8% - 9.4% | 12.6% - 47.9% | - |
| Clinochlore | 0.3% - 3.1% | 1.8% - 4.6% | 0% - 25.8% |
| Monazite | 0% - 5.2% | 2% - 5.1% | 0% - 11.2% |
| Tremolite | 0% - 20% | - | - |
| Margarite | - | 0% - 4.5% | 0% - 9.5% |
| Clinozoisite | - | - | 0% - 7.8% |
| Anorthite | - | - | 0% - 17.4% |