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Data Repository

Supplementary Materials 1. Analytical Procedures

Supplementary Materials 2.

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Supplementary Materials 5.

SUPPLEMENTARY MATERIALS 01:**Analytical Procedures*****Petrogenesis of the Dunité Peak Ophiolite******AJ Parsons, A Zagorerski, WC McClelland, JJ Ryan, CR van Staal, MJ Coleman*****1) U/Pb isotopic system analytical procedures**

A heavy mineral separate from sample 16RAY-AP074A1 was obtained by standard pulverizing, magnetic and heavy liquid methods. Individual zircon grains were handpicked under alcohol, mounted in epoxy resin with natural zircon standards and polished to expose the grain centers for analysis by secondary ion microprobe spectrometry (SIMS) at the U.S. Geological Survey-Stanford University SHRIMP-RG (sensitive high resolution ion microprobe-reverse geometry) facility. Zircon grains were imaged by cathodoluminescence (CL) to expose intra-grain zoning or complexity and aid in placing SIMS spots. The U-Pb and trace element analysis (Supplementary Materials 02) was performed simultaneously following routines outlined in Barth and Wooden (2006) and Mazdab and Wooden (2006). Fractionation corrections were calibrated by replicate analysis of the zircon standard TEM (418 Ma; Black et al., 2004) with a 2σ calibration error for the TEM $^{206}\text{Pb}/^{238}\text{U}$ ratio of 0.48% for the analytical session. Ages were calculated from $^{206}\text{Pb}/^{238}\text{U}$ ratios corrected for common Pb using the ^{207}Pb method and $^{207}\text{Pb}/^{206}\text{Pb}$ ratios corrected for common Pb using the ^{204}Pb method (see Williams, 1998). Initial common Pb isotopic composition was approximated from Stacey and Kramers (1975). The U concentration was calibrated with Madagascar Green (MADDER; 3435 ppm U, Barth and Wooden, 2010). Data reduction and plotting utilized programs Squid 2.51 and Isoplot 3.76 of Ludwig (2009; 2012).

The trace element routine collected 30Si16O, 48Ti, 49Ti, Fe, 89Y, 139La, 140Ce, 146Nd, 147Sm, 153Eu, 155Gd, 163Dy16O, 166Er16O, 172Yb16O, and 180Hf16O simultaneous with U/Pb analysis. Concentrations were calibrated against zircon standards MAD and MADDER (Barth and Wooden, 2010). The estimated errors based on repeated analysis of zircon standard MAD are 3–10 % for P, Y, Hf, Th, and U and the REE except for La (20 %). Chondrite normalized plots were calculated using values from McDonough and Sun (1995). The 49Ti data, with an estimated error of 4% based on analysis of MAD, were used to determine the Ti content to avoid interference of $^{96}\text{Zr}^{2+}$ with the 48Ti peak (Watson and Harrison, 2005). Ti-in-zircon temperatures were calculated using Ferry and Watson (2007), assuming the activity of SiO_2 is equal to one ($a_{\text{SiO}_2} = 1$) and activity of TiO_2 is approximately 0.7 ($a_{\text{TiO}_2} = 0.7$) for rutile-absent siliceous melts (Hayden and Watson, 2007).

2) Whole-rock major and trace element analytical procedures

Whole-rock major and trace element analyses were conducted by Activation Laboratories Ltd (Ancaster, ON). Standard analytical procedures were as follows:

Fused sample is diluted and analyzed by Perkin Elmer Sciex ELAN 6000, 6100 or 9000 ICP/MS. Three blanks and five controls (three before sample group and two after) are analyzed per group of samples. Duplicates are fused and analyzed every 15 samples. Instrument is recalibrated every 40 samples.

(a) Whole-rock major and base metal element analysis: Lithium metaborate/tetraborate fusion – ICP

Samples are prepared and analyzed in a batch system. Each batch contains a method reagent blank, certified reference material and 17% replicates. Samples are mixed with a flux of lithium metaborate and lithium tetraborate and fused in an induction furnace. The molten melt is immediately poured into a solution of 5% nitric acid containing an internal standard, and mixed continuously until completely dissolved (~30 minutes). The samples are run for major oxides and selected trace elements on a combination simultaneous/sequential Thermo Jarrell-Ash ENVIRO II ICP or a Varian Vista 735 ICP. Calibration is performed using 7 prepared USGS and CANMET certified reference materials. One of the 7 standards is used during the analysis for every group of ten samples.

Totals should be between 98.5% and 101%. If results come out lower, samples are scanned for base metals. Low reported totals may indicate sulphate being present or other elements like Li which won't normally be scanned for. Samples with low totals are automatically re-fused and reanalyzed.

Fusion ICP

| Oxide | Detection Limit (%) |
|--------------------------------|---------------------|
| Al ₂ O ₃ | 0.01 |
| CaO | 0.01 |
| Fe ₂ O ₃ | 0.01 |
| K ₂ O ₃ | 0.01 |
| MgO | 0.01 |
| MnO | 0.001 |
| Na ₂ O | 0.01 |
| P ₂ O ₅ | 0.01 |
| SiO ₂ | 0.01 |
| TiO ₂ | 0.001 |
| Loss on Ignition | 0.01 |

Trace Elements

| Element | Detection Limit (ppm) |
|---------|-----------------------|
| Ba | 2 |
| Be | 1 |
| Sc | 1 |
| Sr | 1 |
| V | 5 |
| Y | 1 |
| Zr | 2 |

(b) Trace element analysis: Lithium metaborate/tetraborate fusion - ICP/MS

Samples fused for trace element analysis via ICP/MS are diluted and analyzed by Perkin Elmer Sciex ELAN 6000, 6100 or 9000 ICP/MS. Three blanks and five controls (three before the sample group and two after) are analyzed per group of samples. Duplicates are fused and analyzed every 15 samples. Instrument is recalibrated every 40 samples.

| Element | Detection Limit | Upper Limit | Element | Detection Limit | Upper Limit | Element | Detection Limit | Upper Limit |
|---------|-----------------|-------------|---------|-----------------|-------------|---------|-----------------|-------------|
| Ag | 0.5 | 100 | Hf | 0.1 | 1,000 | Sn | 1 | 1,000 |
| As | 5 | 2,000 | Ho | 0.01 | 1,000 | Sr | 2 | 10,000 |
| Ba | 3 | 300,000 | In | 0.1 | 200 | Ta | 0.01 | 500 |
| Bi | 0.1 | 2,000 | La | 0.05 | 2,000 | Tb | 0.01 | 1,000 |
| Ce | 0.05 | 3,000 | Lu | 0.002 | 1,000 | Th | 0.05 | 2,000 |
| Co | 1 | 1,000 | Mo | 2 | 100 | Tl | 0.05 | 1,000 |
| Cr | 20 | 10,000 | Nb | 0.2 | 1,000 | Tm | 0.005 | 1,000 |
| Cs | 0.1 | 1,000 | Nd | 0.05 | 2,000 | U | 0.01 | 1,000 |
| Cu | 10 | 10,000 | Ni | 20 | 10,000 | V | 5 | 5,000 |
| Dy | 0.01 | 1,000 | Pb | 5 | 10,000 | W | 0.5 | 5,000 |
| Er | 0.01 | 1,000 | Pr | 0.01 | 1,000 | Y | 0.5 | 1,000 |
| Eu | 0.005 | 1,000 | Rb | 1 | 1,000 | Yb | 0.01 | 1,000 |
| Ga | 1 | 500 | Sb | 0.2 | 200 | Zn | 30 | 10,000 |
| Gd | 0.01 | 1,000 | Sm | 0.01 | 1,000 | Zr | 1 | 10,000 |
| Ge | 0.5 | 500 | | | | | | |

Typical ICP/MS Standards Analysis (119 measurements)

| Element | W2 | Cert. | Element | W2 | Cert. | Element | W2 | Cert. | Element | W2 | Cert. |
|---------|-----|-------------|---------|------|-------------|---------|------|-------------|---------|-------|-------------|
| V | 256 | 262 | Y | 21 | 24 | Ce | 24 | 24 | Yb | 2.06 | 20.5 |
| Cr | 90 | 93 | Zr | 99 | 94 | Pr | 2.5 | 5.9? | Lu | 0.33 | 0.33 |
| Co | 44 | 44 | Nb | 7.5 | 7.9 | Nd | 14 | 14 | Hf | 2.64 | 2.56 |
| Ni | 67 | 70 | Mo | 0.7 | 0.6 | Sm | 3.38 | 3.25 | Ta | 0.5 | 0.5 |
| Cu | 105 | 103 | Ag | <0.5 | 0.05 | Eu | 1.1 | 1.1 | W | <0.2 | 0.3 |
| Zn | 72 | 77 | In | <0.2 | - | Gd | 3.5 | 3.6 | Tl | 0.1 | 0.2 |
| Ga | 18 | 20 | Sn | <0.5 | - | Tb | 0.62 | 0.63 | Pb | 8 | 9.3 |
| Ge | 2 | 1 | Sb | 0.78 | 0.79 | Dy | 3.8 | 3.8 | Bi | <0.05 | 0.03 |
| As | <5 | 1.24 | Cs | 0.95 | 0.99 | Ho | 0.76 | 0.76 | Th | 2.3 | 2.5 |
| Rb | 20 | 20 | Ba | 164 | 182 | Er | 2.3 | 2.5 | U | 0.49 | 0.53 |
| Sr | 193 | 194 | La | 11.3 | 11.4 | Tm | 0.32 | 0.38 | | | |

3) Sm/Nd isotopic system analytical procedures

Silicate rock powders are spiked with a mixed ^{148}Nd - ^{149}Sm spike before were dissolved in the mixed acid of ~29 M HF and ~16M HNO₃; the samples are then dried down on the hotplate before are re-dissolved with 8M HNO₃ and 6M HCl sequentially. The dried residue of samples are dissolved in 2.5 M HCl and are loaded into 14-ml Bio-Rad borosilicate glass chromatography columns containing 3.0 ml of Dowex AG50W-X8 cation resin. The columns then are washed with 23 ml of 2.5 M before the rare earth elements are eluted using 9 ml of 6M HCl. REE fractions are dissolved in 0.26M HCl and are loaded onto Eichrom Ln Resin chromatographic columns containing Teflon powder coated with HDEHP [di(2-ethylhexyl) orthophosphoric acid, Richard et al., 1976]. Nd is eluted using 0.26M HCl, followed by eluting Sm using 0.5M HCl.

The isotope ratios are measured using a ThermoFinnigan's Trion TIMS. Samples are loaded with H₃PO₄ in double rhenium filament assembly. The isotope ratios are measured at temperatures of 1500-1700 °C. Isotope ratios are normalized to $^{146}\text{Nd}/^{144}\text{Nd} = 0.72190$. An IGGRC's in-house Nd standard were routinely measured with $^{143}\text{Nd}/^{144}\text{Nd} = 0.511831 \pm 0.000006$ (1 σ) over a period of three years; this value is equivalent to $^{143}\text{Nd}/^{144}\text{Nd} = 0.511860$ for the La Jolla Nd standard; Sm and Nd concentrations were measured precisely within 1%, while $^{147}\text{Sm}/^{144}\text{Nd}$ ratios are reproducible to 0.5%. Analyses of the USGS standard BCR-2 yield Nd = 28.59 ppm, Sm = 6.647 ppm, and $^{143}\text{Nd}/^{144}\text{Nd} = 0.512644 \pm 0.000006$ (1 σ , n=4). Total procedural blanks for Nd are less than 50 picograms.

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