crystals show no major element zoning, and ion microprobe results indicate trace element homogeneity. As analytical or experimental problems will lead to all partition coefficients converging on 1, the low measured partition coefficients for HFSE (0.004 to 0.00005) point to the robustness of our results. Partition coefficients for REE increase in compatibility from HREE (0.006 to 0.003) to LREE (0.045 to 0.017). LILE partition coefficients range from ∼1.2 for Sr to lower values for Cs, Rb, K and Ba (0.18 to 0.005). Finally, Ds for the light elements range from 0.4 to 0.02 and D_U and D_{Th} vary between 0.0002 and 0.0005.

V51B-1000 0830h POSTER

Compression Mechanism of the Pyroxene Kosmochlor

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In an effort to understand pyroxene compressibility systematics, the crystal structure of synthetic kosmochlor, $NaCrSi_2O_6$, has been studied by X-ray diffraction at high pressures. A single crystal of kosmochlor was compressed to 7.8 GPa in a four-pin diamond anvil cell using 4:1 methanol:ethanol pressure medium. Data were collected on an automated Picker diffractometer with unfiltered MoKa radiation. Unit cell parameters were determined from the fitted positions of up to 16 reflections in the 2θ range of 6° to 34°. Single crystal X-ray intensities were collected and structures were refined at 0.0001, 1.14, 2.22, 3.53, 5.05, 6.25, 7.08, and 7.40 GPa.

Fitting of the pressure-volume data to a third order Birch-Murnaghan equation gives $K_0 = 133(2)$ GPa and $K'_0 = 2.5(5)$. Strain ellipsoids were determined from cell parameters and indicate extremely anisotropic compressibility with unit strain ratios of 1:2.01:1.74, as anisotropic as olivine. The strain axes are distinct from the stacking direction. Variations in bond lengths, angles, and polyhedral volumes will be discussed. Preliminary electron density calculations indicate a change of 6 to 8 in the coordination number of the Na atom at ∼7.4 GPa without a change from $C2/c$ symmetry. Additional data at higher pressures are currently being collected to determine whether the increase in coordination number of the Na signifies a $C2/c$ to $C2/c$ phase transition.

V51B-1001 0830h POSTER

Solubility of TiO_2 in Olivine from 1 to 8 Gpa

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Laboratory experiments have been conducted to determine the solubility of TiO_2 in olivine from 1 to 8 GPa, between 1127° and 1560° C. These experiments were performed in the piston cylinder device (1 and 2 GPa) and the MA6/MA8 multianvil apparatus (3 to 8 GPa), using starting materials consisting of San Carlos olivine and 20 wt % TiO_2 powder. Excess TiO_2 forms rutile in all run products. The presence of rutile imposes unit activity of TiO_2 in olivine and, thus, we measure maximum solubilities of Ti in olivine. This situation differs from studies in which olivine is in equilibrium with ilmenite [1,2,3]. Electron microprobe analyses of run products show that the TiO_2 content of olivine has positive pressure dependence between 1 and 8 GPa. Olivine contains 0.2 wt % TiO_2 between 1 and 3 GPa, at 1127° and 1460° C; TiO_2 contents increase to 0.5 wt % between 3 and 8 GPa. Dobrzhinetskaya et al. [1] and Green et al. [2] observed a similar positive pressure dependence on TiO_2 solubility in olivine between 6 and 14 GPa. However, TiO_2 contents of olivine from 6 to 8 GPa in these studies are lower than TiO_2 contents we find between 6 and 8 GPa. Lower TiO_2 contents presumably reflect ilmenite-olivine equilibria. In contrast, Okamoto et al. [3] and Ulmer and Trommsdorff [4] did not report a positive pressure dependence on TiO_2 solubility in olivine, although rutile was stable in the experiments of [4]. The positive pressure dependence of TiO_2 solubility is important for the interpretation of high pressure metamorphic rocks containing abundant exsolved titanate rods, which on recombination can yield 0.6 wt % TiO_2 in host olivine before exsolution [5]. We estimate from our data that olivine containing 0.6 wt % TiO_2 originated at a minimum depth of 10 GPa. The positive pressure dependence of TiO_2 in olivine offers an additional pathway for the transport of Ti and other high field strength elements into the mantle, and these elements may later be recovered by rising mantle plumes. [1] Dobrzhinetskaya et al. (2000) Chem. Geol., 163, 325-338; [2] Green et al. (1997) Tectonics, 279, 1-21; [3] Okamoto et al. (1997) EOS, F761; [4] Ulmer and Trommsdorff (1997) TERRA, 9, 39; [5] Green et al. (1997) Science, 278, 704-707

V51B-1002 0830h POSTER

Neutron-beam CT of magmatic rocks: Method development and applications

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A 2-megawatt TRIGA reactor, now owned and operated by UC Davis as a research facility, was especially designed and built by the USAF with a large L/D for neutron-beam radiography of aircraft parts. More recent efforts in computed tomography (CT) have established capabilities of 3-D imaging of a broad range of geological materials, including textured igneous rocks up to 10's cm in size. Neutron-beam imaging is complementary to X-ray CT, especially because of the high neutron cross-sections for many light elements that are not easily detected by X-rays. Our goal is to optimize neutron-beam CT techniques for quantitative studies of igneous textures and mineralogy. To this end, we have made improvements in both image acquisition and data processing. Specifically, we have measured the attenuation coefficient for diabase for beam-hardening corrections. We have characterized the dark charge contribution and developed new strategies for flat field corrections. We have increased our sampling density to 360 images per 180 of rotation, and now correct for beam divergence. Each of these procedures contribute to a reduction in ring artifacts and thus improve image resolution. To maximize attenuation contrast, we collect images with a Cd-filtered neutron-beam. Other energy filtering techniques are also being explored. We will show examples of this imaging technique as well as applications to gabbroic rocks of the Skaergaard intrusion which involve the quantification of compaction gradients.

V51B-1003 0830h POSTER

A Quantitative Evaluation of the Relationship Between Magnetic and Silicate Fabrics in Cumulates with no Discrete Magnetite

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We have conducted a detailed comparison of the magnetic and silicate fabrics in ultramafic to mafic cumulates in order to quantitatively evaluate the relationship between them. Oriented block samples were collected from the Stillwater Complex, Montana, below the level at which magnetite becomes cumulus. No discrete granular magnetite has been found using either microscopy or SEM imaging. Samples are fresh to variably altered with a broad range of textures and mineralogies including: orthopyroxenite, anorthosite, gabbro, norite, gabbronorite, and olivine-gabbronorite. Anisotropy of magnetic susceptibility (AMS) and anisotropy of anhysteretic remanence (ARM) were measured on minicores drilled from the blocks after three orthogonal cuts were made for oversized (80 x 46 mm) thin-sections. C-axis orientation projections of all grains were measured, allowing construction of the 3D-fabric tensor for comparison with the magnetic volume fabrics.

Comparison of bulk susceptibilities with whole-rock Fe contents indicates that although no discrete magnetite is present, most samples must contain a small amount of magnetite (typically a few 10s to 100s ppm). ARM measurements suggest that much of the magnetite occurs as submicron grains. We suggest that these are produced by exsolution from the cumulus minerals.

The directions of AMS, ARM and silicate ellipsoids agree within error for most samples, particularly those with substantial pyroxene. Anorthositic samples (with low susceptibility and low degree of AMS) sometimes have poorer correspondence with silicate fabrics. However, in many of these cases the ARM anisotropy is much larger and is coaxial with the silicate fabric. The relationship of eigenvalues of the silicate and magnetic tensors is more complicated, with some samples matching well and others with maxima and minima switched. This phenomenon may, in some cases, be related to the presence of single domain magnetite.

V51B-1004 0830h POSTER

In-situ Trace Element and REE Analysis of Garnet Porphyroblast from the Murphy Belt Drill Core by 213 nm Laser Ablation High Resolution ICPMS

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Laser ablation coupled with high resolution inductively coupled plasma mass spectrometry (LA-HR-ICPMS) is a powerful tool for in-situ trace element analysis of solid samples on the micron scale. Recent development of the 213 nm (quintupled) Nd-YAG laser has significantly improved upon the more widely used 266 nm laser. In this study we focus on analysis of zoned garnets from the Murphy Marble Belt with a Universal Platform (UP) Merchantek/New Wave 213 nm laser ablation system, coupled with a Finnigan MAT Element2 high resolution ICPMS which is equipped with the fast scanning power supply magnet. Laser ablation parameters included 60 um spots size, 100% energy level, repetition rate of 20Hz and scanning speed of 16-20 um/seconds. Garnets were analyzed for Mg, Rb, Sr, Y, Zr, Nb, Hf and REE and the data used here were obtained by using a line scan across the diameter of the garnet porphyroblasts.

Aluminous schist from drill core from the Murphy Marble Belt of the Western Blue Ridge of Georgia contains two generations of garnet, gt I and gt II. Gt II occurs as stand-alone grains and as overgrowths on gt I. Gt I grew in conjunction with development of biotite (bi) schistosity. Gt-bi geothermometry yields 512-531oC for gt I, consistent upper greenschist metamorphism. Growth of gt I was followed by growth of gt II, kyanite (ky), and staurolite (st), in turn followed by growth of sillimanite (si), large muscovite (ms) porphyroclasts, (and gt II?), associated with a high-T mylonitic event in which plagioclase and aggregates of ky+st+bi were converted to porphyroclasts, lying in a medium grained si-ms-bi schistosity. This was followed by a retrograde mylonitic event which partially converted si, ky, st, and large ms to fine grained ms schistosity which is the dominant schistosity in the rocks.

Gt II is distinctly higher in CaO and lower in MnO than gt I, suggesting that it grew under high pressure, perhaps resulting from overthrusting which formed the high-T mylonitic textures. Mg, REE and trace element data from gt I and gt II also show pronounced compositional differences. Gt I are more enriched in HREE, Y, Zr and Nb than gt II. On the other had gt II is distinctly more enriched in LREE , Ca, Rb and Sr. The co-variation of Ca-Sr is one strong indication of the validity of the data. Spot-to-spot analysis which of greater challenge is currently underway where a typical procedures involves internal standardization to one major element (e.g., Ca or Mg) and external standardization to NIST 612.

V51B-1005 0830h POSTER

Anorthite Weathering: Rates from Vertical Scanning Interferometry

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Feldspar weathering plays an important role in many environmental and engineering problems, including waste disposal, groundwater movement, and diagenesis. As the most abundant rock forming minerals in the Earth's crust, feldspar dissolution rates are especially important parameters in global flux models, as well as in smaller scale kinetic dissolution models.

We present results based on the dissolution rates of anorthite measured during single-crystal, flow-through experiments at varying temperature and saturation state. The experiments are conducted in a 0.01M solution of sodium tetraborate with pH 9. Saturation states with respect to anorthite are controlled by adding known concentrations of aluminum chloride, calcium chloride, and sodium meta-silicate.

Using vertical scanning interferometry we obtain absolute measurements of the rate of the mineral's surface normal retreat. From the molar volume of the mineral and the velocity of the surface normal retreat we calculate absolute rate constants. No external measurement of surface area is necessary. Each measurement by the interferometer produces up to 600,000 individual rate data. Statistical analyses of these data

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