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Melting relations on the multicomponent omphacite – garnet join are more under influence of the eutectic jadeite – pyrope system than the peritectic diopside – pyrope one if the relation revealed at 4 GPa (Bell & Davis, 1969; Litvin, 1991) are of value for 7 GPa. Phase equilibria on the pyrope – almandine join at 7 GPa (Butvina et al., 2001) are characterized by the complete series of solid and liquid solutions without extreme points (Roseboom's type I). Constitution of the ternary omphacite – (pyrope + grossular) – (almandine + grossular) phase diagram may be rather influenced with jadeite – pyrope system than diopside – pyrope one, and it is expected to characterize by divariant eutectic line and not include invariant equilibria at 7 GPa. The ternary melting equilibria are of key importance for the origin and evolution of diamond – bearing eclogites in the mantle conditions. Support: grant 01-05-64508 Of RFBR, 215-05 Integracia.

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EXPERIMENTAL DEFORMATION OF CLINOPYROXENE AGGREGATES

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We have conducted an experimental deformation study on the rheological behavior of clinopyroxene aggregates under dry conditions at low strains in a uniaxial deformation apparatus and at high strains using a torsion set-up. Coarse-grained natural clinopyroxene samples from Sleaford Bay and fine-grained aggregates hot-pressed from Sleaford Bay powders were first dried in a 1-atm oven at 1000°C for 10 hours under controlled conditions. The samples were then deformed in a Paterson apparatus at confining pressures of 300 - 430 MPa and temperatures of 1150-1250°C with the oxygen fugacity buffered by either nickel-nickel oxide or iron-wüstite powders.

Our low-strain uniaxial study yielded a flow law for dislocation creep for natural clinopyroxenite with a stress exponent of $n = 4.7 \pm 0.2$ and an activation energy for creep of $Q = 760 \pm 40$ kJ/mol. In the hot-pressed samples, mixed-mode deformation behavior was observed, with diffusional creep ($n = 1$) at lower differential stresses and dislocation creep (with n and Q similar to those of the natural samples) at higher differential stresses. Within the dislocation creep field, the predried hot-pressed samples generally yielded creep rates that were about an order of magnitude faster than the natural samples. Optical and electron microscope investigations of the deformation microstructures of the natural and hot-pressed samples show evidence for mechanical twinning and activation of dislocation slip systems.

High-strain deformation experiments were performed in torsion on natural and hot-pressed aggregates under similar conditions. Simple-shear microstructures and textures were analyzed using optical microscopy and EBSD. Hot-pressed samples were significantly weaker than natural samples. Stepping tests were performed to determine the evolution of the stress exponent with strain. We present a comparison of our

rheological data at low and high strains, and discuss the difference in rheological behavior between natural and synthetic aggregates.

A HT-XRD STUDY OF SYNTHETIC MAGNESIAN-FERRISPODUMENE: TRANSITION TEMPERATURE VS. CATION COMPOSITION AND ORDERING

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We synthesised magnesian-ferrispodumene in the MgO-LiO₂-FeO-SiO₂-H₂O system. Single-crystal structure refinement at room T and EMP analyses show that this pyroxene is monoclinic $P2_1/c$ with composition $M^2(Li_{0.85}Mg_{0.09}Fe^{2+}_{0.06})M^1(Fe^{3+}_{0.85}Mg_{0.15})Si_2O_6$ ($a = 9.638(3)$ Å, $b = 8.709(2)$ Å, $c = 5.258(2)$ Å, $\beta = 109.83(3)^\circ$, $V = 415.2$ Å³). Li is ordered at M2, and Fe³⁺ at M1, Mg and Fe²⁺ distribute over both octahedral sites. Structure refinements done at different temperatures show that at 105°C magnesian-ferrispodumene undergoes a reversible displacive phase transition $P2_1/c \Rightarrow C2/c$. It is evidenced by the disappearance of the $h+k = 2n+1$ reflections and by abrupt changes in the unit cell parameters. It is known from previous HT-XRD work that in Li-clinopyroxenes the transition temperature is inversely related to the size of the M1 cation [70°C in LiCrSi₂O₆ (Behruzi et al., 1984); 10°C in LiGaSi₂O₆ (Sato et al., 1995); -44° in LiFe³⁺Si₂O₆, (Redhammer et al., 2001)]. The studied crystal has an aggregate ionic radius at M1 larger than LiFe³⁺Si₂O₆; therefore its transition temperature should be < -44°C. It is also known (Prewitt et al., 1971) that the transition temperature in ferromagnesian clinopyroxenes increases with decreasing aggregate cation radius at M1 and M2, and thus depends on the Fe²⁺ ordering between M1 and M2 (Cámara et al., 2002). The transition temperature experimentally measured for magnesian-ferrispodumene can be thus explained by the presence of significant Mg at M2 which shortens the aggregate radius at that site. This study suggests the possibility of a complex thermodynamic behaviour accompanying variable cation substitutions at both the M1 and M2 sites in clinopyroxenes.

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REACTION SEQUENCE VS CHEMICAL COLLINEARITY IN THE P_nW POLYSOMATIC SERIES. A HREM STUDY OF Mn-PYROXENIDS FROM CAMPIGLIA MARITTIMA (LIVORNO, CENTRAL ITALY)

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Late crystallisation stages of the Campiglia Marittima quartz-clinopyroxene-ilvaite skarn were characterised by Mn-activity increase at the metasomatic front. Mn-pyroxenoids became stable with respect to johannsenite. Textural observations at the petrographic thin section scale suggest two distinct crystallisation mechanisms: (a) pyroxenoids overgrowing johannsenite and directly precipitating from a fluid rich system; (b) pyroxenoids pseudomorphically replacing for pyroxenes. We focused the TEM investigation on these latter sites, finding microstructures distinctive of a solid-state transformation involving the movement of a reaction front through the original johannsenite (i.e. "bulk reaction mechanism"; Veblen, 1985). Comparatively few observations recall a unit-cell by unit-cell topotactic replacement of johannsenite by pyroxenoids (i.e. "lamellar reaction mechanism"; Veblen, 1985). Johannsenite-pyroxenoid solid-state transformation occurred at temperatures lower than 260° C. Either ordered pyroxmangite or disordered intergrowths of rhodonite and pyroxmangite occur at the reaction front with johannsenite, showing $(001)_{\text{Pxd}} // (11\bar{1})_{\text{Jh}}$. Based upon existent ternary phase diagrams for the system $\text{CaSiO}_3\text{-MnSiO}_3\text{-(Mg,Fe)SiO}_3$ (Abrecht, 1985), minor changes in the iron plus magnesium concentration are supposed to play a relevant role in determining the mineral assemblage at the reaction front. Moreover, crystal chemical considerations indicate that the maximal calcium content of pyroxmangite is 2/7, rather than 1/7. In the light of these observations, pyroxmangite may behave as stable phase in the replacement of johannsenite rather than metastable as previously stated. As further remark, the P_nW polysomatic series can now be considered not only structurally but also compositionally collinear.

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DISSOLUTION OF MAFIC MICROGRANULAR ENCLAVES BY DECOMPRESSION MELTING IN A WATER-SATURATED GRANITIC MAGMA

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Several experimental runs on interaction between tonalitic microgranular enclaves and a granitic melt have been performed in "piston - cylinder" apparatus (experimental

details in Castro et al. 1999), using as starting materials small rock fragments of a tonalitic enclave and powdered hydrous granitic synthetic glass. Our experiments were carried out at pressures from 10 kbar to 4 kbar, at three different temperatures: 900°C, 850°C and 750°C, to check the consequences of decompression. Results at 10 kbar show no changes in the tonalitic enclaves and only partial crystallization of the granitic glass for low temperature, but for higher temperatures, partial dissolution of the tonalitic enclaves by the more acid hydrous melt can be observed by identifying dissolution textures in the tonalitic fragments, and by changes in the melt (glass) composition that becomes more monzogranitic compared with the starting composition of the enclosing glass. Experimental runs were held at 10 kbar for 4 days and then brought to a lower pressure of 4 kbar for 4 days for a given temperature, in this process the dissolution of the tonalitic enclave is enhanced due to reaching water saturation of the melt by dropping pressure. Changes of the analyzed melt to more CaO, FeO and MgO compositions as well as dissolution textures on the crystal surfaces which formed the tonalitic enclave were monitored. These results have implications in the generation of monzogranite magmas from pelitic or greywacke rock sources in which the CaO content is insufficient to produce monzogranite melts. The tonalitic enclaves that are partially dissolved may be early intrusions into the migmatitic area or intrusions of intermediate magmas coeval with granite magma generation. Many geochemical and isotopic features of monzogranites (e.g. the low Sr isotopic ratios) are accounted for by this mechanism of enclave dissolution during ascent and emplacement.

Castro A, Patiño-Douce AE, Corretgé LG, de la Rosa JD, El-Biad M & El-Hmidi H, *Contrib Mineral Petrol*, **135**, 255-276

PRELIMINARY RESULTS ON EXPERIMENTAL CRYSTALLISATION UNDER COAXIAL STRESS

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Magmatic fabrics are common in volcanic and plutonic rocks. In the latter, these textures are often used as markers of regional deformation patterns. However, the origin of such fabrics is still not well understood. The most commonly accepted hypothesis is that these textures originate by a magmatic flow mechanism. We are currently testing another hypothesis, namely: the possibility that deformation affects crystallisation and thus, fabric patterns.

The main difficulty in such experiments comes from an antagonism between the low viscosity of magmas (i.e. fast deformation) at relevant geological temperatures and the slow kinetic of crystallisation. To overcome this problem, we start our deformation experiments with an already partially crystallised magma (crystallinity = 30%), which increases the viscosity by about 1 order of magnitude

The experimental procedure is divided in two steps: synthesis in IHPV at 850°C, 300 MPa, during 10 days, of partially crystallised glass cylinders (starting material: a rhyodacitic glass,

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69% SiO₂, with 3 wt% bulk H₂O), followed by the deformation of the cylinder at the same pressure but at a temperature below that of synthesis (in the range 700-800°C), in order to induce a second crystallisation stage. The effect of deformation is characterised by comparing deformed and undeformed charges produced at the same temperature from the same starting materials.

To this end, we have designed a deformation apparatus (Champallier et al., 2001). This first prototype works at high strain rate and does not allow to accurately determine the onset of deformation at HP-HT. The resulting deformed cylinders all displayed complex crossed fabric patterns difficult to interpret.

A new deformation apparatus, overcoming the problems of both onset and strain rate, is currently being tested. It will be presented with the results on fabrics and nucleation obtained from deformation/crystallisation experiments.

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EXPERIMENTAL INVESTIGATION OF Cl AND H₂O SOLUBILITIES IN GRANODIORITE MELTS

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Experimental determinations of the chlorine solubility in the model water-saturated melts of granodioritic composition have been done in the wide range of the alteration of water-chloride fluid compositions from 0 to 98 wt.% chlorides at 1 kbar - 1000°C and 0,3 kbar - 1250°C. Water forms (H₂O mol., OH) content have been determined in the experimentally derived glasses by precise IR-FTIR spectroscopy and considered together with Cl content. The same glasses are characterized with common IR-spectroscopy in respect to their medium-range structure. The influence of various contents of chlorine, water and alkali and earth-alkali metals on the medium-range structure of quench glasses have been characterized. The complex infrared absorption bands in the range of frequencies 300-600 cm⁻¹ have been approximated by two contours, those are related to oscillations of four- and six membered aluminosilicate and silicate rings (Simakin et al., 1998; Sykes et al., 1990; Zotov et al., 1998). Possible model of chlorine solubility is suggested based on the data obtained. The following main results can be enumerated. (1) At P=1 kbar and at total saline fluid more than 15 wt.% the chlorine and water solubilities in granodiorite melt are 0,5-0,7 wt.% and 3,5-3,65 wt.% accordingly. Abrupt increase of chlorine solubility (to 0,9-1 wt.%) occurs at total saline fluid 6-15 wt.%, then water content decreases to 3,0-3,3 wt.%. At saline fluid 0% the water content in the quench glasses is 3,0-3,3 wt.%. (2) Transition from feldspar-like (4-membered) aluminosilicate structural elements to tridimite-like (6-membered) ones at the action of dissolved water and chlorine has been fixed by IR-spectroscopy of quenched glasses. (3) TEM microscopy proves absence of the salt phase in the studied glasses. (4) Data obtained can be interpreted from the point of view of the structure of the polymerized granite-granodiorite melts. Chloride of metals seems to

form fill in solutions in the aluminosilicate network. Incorporation of chlorides is assumed to be accomplished by the formation of cavities made of 6-membered (tridimite-like) aluminosilicate structural elements. [The work has been supported by the RFBR (projects 99-05-65439, 99-05-64106, 00-15-98504 and 01-05-64837).]

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PHASE DIAGRAM OF MgSiO₃: NEW DAC DATA

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New data on the equilibrium phase relations in the MgSiO₃-system are presented. Experiments were performed in the diamond cell by heating pure glass samples in rhenium or iridium micro-heaters embedded in an argon pressure medium with two YLF lasers. The transformations of lower pressure polymorphs to perovskite and reversals were measured by Raman spectroscopy on the temperature-quenched samples. Pressures were measured from unheated ruby chips in the argon pressure medium. The slope of the MgSiO₃ ilmenite - perovskite phase boundary, measured in the range of 21-24 GPa and 1800-2250 K, is strongly negative (-0.005 ± 0.001 GPa/K). This phase boundary yields the same temperature of 1800-1900K at the pressure of the 660 km seismic discontinuity (23.8 GPa) as the γ-spinel to perovskite + MgO transition in the Mg₂SiO₄ system (Chudinovskikh & Boehler, 2001; Shim et al., 2001). At higher temperatures the P-T conditions of the stability fields of MgSiO₃ garnet and (β-phase + stishovite) differ from most of the multi-anvil results but show good agreement with thermodynamic data (Fei et al., 1990).

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AB INITIO CRYSTAL STRUCTURE REFINEMENT AND PROTON DYNAMICS OF THE HYDROUS FORSTERITE ($[\text{MgH}_2\text{SiO}_4] \cdot 3[\text{Mg}_2\text{SiO}_4]$)

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Recently Hy-2a hydrous olivine ($[\text{MgH}_2\text{SiO}_4] \cdot 3[\text{Mg}_2\text{SiO}_4]$), a new DHMS phase was found as nanometer-sized inclusions in Fo_{82} natural forsterite from the mantle peridotite nodule 9206, Udachnaja kimberlite pipe (Khisina et al 2001). In this presentation we are going to report the results of *ab initio* structure optimization of the hydrous olivine, based on the crystal chemical model suggested earlier by Khisina and Wirth (in press). The purpose of this study was to obtain the most stable configuration of protons in the Hy-2a structure possessing the lowest lattice energy, by assuming formation of Me^{2+} vacancies in either M1 or M2 octahedral sites (Churakov et al., submitted).

The calculations predict a preferential stability of structures with hydrogen atoms located in M1 vacancies relative to configurations formed by M2 vacancies or ones with protons in interstitial sites. The structures with the M2 vacancies are comparable in energy with configurations characterized by interstitial location of protons. In the lowest energy structures found for the Hy-2a all of the hydrogen atoms are located in the vacant M1 polyhedrons. Optimal arrangement of protons in the vacancy is distinguished by two bifurcated hydrogen bonds, O1-H1...(O2/O3) and O2-H2...(O1/O3). Two further structures with slightly higher energies are characterized by short hydrogen bonds O2-H2...O1 and O3-H3...O1 or bifurcated hydrogen bonds O2-H2...(O3/O1) and O1-H1...(O3/O2). Having little higher energy over optimal configuration these structures may also present in natural samples in minor amount. Analyses of *ab initio* molecular dynamics trajectories carried out on the Hy-2a structure at 1000°C indicate that the H atoms in M1 vacancies remain preferentially bonded to the O1 and O2 sites.

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HP STRUCTURAL EFFECTS AND COMPRESSIBILITY OF BIKITAITE

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Bikitaite is a rare zeolite, belonging to the mordenite group. It is the only natural zeolite with mono-dimensional water chains as extra-framework content, which may make it a good candidate for the storage of nanophases in complex matrices. Its baric behaviour was investigated in the range 0-4 GPa by X-ray single-crystal diffraction with a Merrill-Bassett diamond anvil cell using glycerol, as a non penetrating pressure-transmitting medium; ruby chips and a small crystal of quartz as pressure calibrants. A strong anisotropic compression was observed by linear regression of lattice parameters-*P* data, bikitaite being softer along the *c* axis ($\beta_c = 9.3(1) \cdot 10^{-3} \text{ GPa}^{-1}$), than along *b* ($\beta_b = 6.6(1) \cdot 10^{-3} \text{ GPa}^{-1}$) and *a* ($\beta_a = 2.4(1) \cdot 10^{-3} \text{ GPa}^{-1}$) ($\beta_a:\beta_b:\beta_c = 1: 2.75 : 3.9$). Fitting the cell-volume - pressure data set to a second order Birch-Murnaghan equation of state, as indicated by the finite strain-stress plot, yielded $K_0 = 44.2(4) \text{ GPa}$, with $K_1 = 4$ and $V_0 = 295.58(2) \text{ \AA}^3$. The evolution of the bikitaite structure with *P* was studied by comparing of the results of refinements with data collected at 0.0001, 3.2 GPa and after decompression. The structure can be described as sheets of six-membered rings parallel to (001), connected by pyroxene-like chains. 8-ring and 5-ring channels run along [010] and inside the 8-ring channel there is a unidimensional chain of water molecules, which is linked to the framework through the extra-framework Li atoms. Under pressure, the kinking of the pyroxene-like chain decreased the free diameters of the 5-ring channels, strongly reducing the distance between the *ab* planes. On the contrary the "hexagonal planes" were more rigid. The positions of the extra-framework cations and water were maintained at HP even through the configuration of the water chains changed slightly: the distances between the water molecules decreased whereas the kinking angle of the chain increased.

PHASE EQUILIBRIA AND PRE-ERUPTIVE P-T-*f*O₂-*f*H₂O-*f*S₂ CONDITIONS OF DACITE FROM VOLCÁN SAN PEDRO (CHILEAN ANDES)

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The pressure, temperature, oxygen fugacity, volatile content and compositions of subduction related silicic magmas is a highly investigated topic because of known climatic and societal potential hazardous effects, and the implications for the differentiation of the continental crust. Melt inclusions combined with thermobarometers provide a means of estimating such parameters, but a complementary approach is to perform phase equilibrium experiments at various P-T-*f*volatile conditions. With the assumption that the bulk-rock composition is representative of a liquid, we have performed a phase equilibrium study of a dacite (66 wt% SiO₂, 2.7 wt% K₂O) from Volcán San Pedro, the Holocene edifice of the Quaternary Tatara-San Pedro complex (Chilean Andes). The dacite contains phenocrysts of plagioclase (Pl), hornblende (Hbl),

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biotite (Bt), clinopyroxene (Cpx), orthopyroxene (Opx), Fe-Ti oxides (Mt), pyrrhotite, and apatite. Coexisting Fe-Ti oxides gave a pre-eruptive temperature of $\sim 850^\circ\text{C}$ and an $f\text{O}_2 \sim \text{NiNiO}+1$, whereas pyrrhotite composition indicates an $f\text{S}_2 \sim 0.02$. We have performed experiments in IHPV at $800\text{-}950^\circ\text{C}$, $100\text{-}400$ MPa, and with redox conditions from the Ni-NiO buffer to ~ 2.5 log units above. Water contents ranged from undersaturated ($\text{XH}_2\text{O} = 0.6$) to saturation, and S from 0 to 1 wt% bulk. The full mineral assemblage (Pl+Cpx+Opx+Hbl+Bt+Mt) present in the lava is not stable at any of the investigated experimental conditions, notably by the lack of Cpx+Bt coexistence. Moreover, in S-free experiments Bt is only stable at $< 825^\circ\text{C}$, which is lower than the Fe-Ti oxides temperature. In contrast, in experiments with 0.5-1 wt% added S, Bt is stable up to 875°C (+Hbl+Opx+Pl+anhydrite+pyrrhotite). This suggests that the San Pedro dacite magma was stored at ~ 6 km, at 850°C , close to water-saturated conditions, with a log $f\text{O}_2$ of NNO+1 to NNO+2, and importantly, contained significant amounts of sulfur ($0.1 < S < 1$ wt% bulk).

HIGH-TEMPERATURE DENSITY OF LANTHANIDE-BEARING MELTS: PRELIMINARY RESULTS

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Igneous rocks commonly contain several hundred ppm of lanthanides, or under exceptional circumstances even more, distributed in various concentrations amongst major and accessory minerals. In general, lanthanides are partitioned more extremely than major elements making them more sensitive indicators of the petrological and mineralogical processes that occur. Therefore, they are a powerful tool in the thermodynamical modelling to accurately predict the crystal-melt phase equilibria in a magma, in order to trace petrogenetic processes and define compositional heterogeneities within the upper mantle. The development of such mathematical models requires a reliable thermodynamic database which includes volumetric data available for both major and trace element oxide liquids. Efforts have been made to extend the volumetric database of silicate melts on a variety of multi-component systems for the most naturally abundant oxides during the last decades. However, there is no reliable volumetric dataset for other significant oxides, such as lanthanides. Therefore, in order to fill this gap and to provide a new volumetric dataset, which will allow the available models in the literature to be extended to lanthanide-bearing liquids, we are conducting density measurements on various lanthanide-bearing silicate melts using the Pt-based double-bob Archimedean method. In this paper, we present preliminary density measurements obtained in air from 1350 to 1550 K for various lanthanide-bearing sodium disilicate melts (from cerium to lutetium including lanthanum). The densities range from 2.25 to 2.83 g/cm³ and indicate that adding lanthanide oxides leads to an increase in melt density that varies as the atomic number of the lanthanides increases. Further investigations on different compositions containing various amounts of lanthanide are still in progress in order to determine the partial molar volume of the lanthanide oxide liquids.

CARBONATES VS. GRAPHITE STABILITY IN HYDROUS MAFIC SYSTEMS AT HIGH-PRESSURE

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The analysis of modern oceanic crust show not only major addition of H₂O, but also of CO₂, as main volatile components. Carbon-bearing phases and C-O-H fluids are therefore expected to play a fundamental role in the evolution of subduction zone systems (Yaxley & Green, 1994; Molina & Poli, 2000; Kerrick & Connolly, 2001).

In order to determine the mutual stability of carbonates and graphite in metamorphosed altered oceanic crust, we performed high pressure experiments in the model system Na₂O-CaO-FeO-MgO-Al₂O₃-SiO₂, in the presence of a C-O-H fluid, where $f\text{H}_2$ is controlled by Ni-NiO (NNO) and hematite-magnetite (HM) buffers. Experiments were carried out on seeded gels using both end-loaded and single-stage piston-cylinder apparatus, at pressures up to 3 GPa and temperatures to 730°C . C-O-H fluid phase was generated from oxalic acid dihydrate and from silver oxalate. Two basaltic compositions at variable XMg were investigated. In agreement with previous experiments by Molina & Poli (2000), a large amphibole-carbonate phase field is present at $P \leq 2$ GPa, with a single carbonate (calcite or dolomite) at $P < 1.6\text{-}1.8$ GPa and coexisting magnesite and dolomite at higher pressure. The abundance of carbonates is closely related to the amount and composition of fluid added. However, in experiments at 2.2 and 2.4 GPa buffered by NNO, two carbonate assemblages are replaced by graphite \pm NaCaAl silicate (scapolite), whereas graphite disappears in HM runs, being scapolite the main carbon bearing phase.

Preliminary experimental results suggest that the stability of magnesite and dolomite in deeply subducted oceanic crust is restricted to highly oxidizing conditions and H₂O-poor bulk compositions.

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CHARACTERIZATION OF A UHP PHENGITE 3T (SULU, CHINA) AND OF ITS EXSOLVED MILLIMETRIC LAMELLAE OF PHLOGOPITE

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Single-crystal X-ray diffraction study was performed on a phengite 3T from a quartz-phengite vein, crystallized in UHP metamorphic conditions (Dabie-Shan complex, Sulu region, $P \sim 30$ kbar, $T \sim 750^\circ\text{C}$) in presence of hydrothermal fluids. The flakes show deep green colour, are not deformed, large (decimetres) and thick (centimetres). Anisotropic refinement

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(s.g. P₃12, a=5.2248(6)Å, c=29.737(5)Å) converged to R=3.5. According to the values of the refined electron content no ordering occurs in the octahedral sites (14.3(2) el in M2 and 14.7(2) el in M3); a significant electron density residual (about 0.7 el in the ΔF; 0.3(1) el refined value) occurs in the 'empty' M1 site. These results are in agreement with the WDS electron-probe chemical analysis (K_{0.95}Na_{0.01}Ba_{0.01})(Al_{1.37}Fe_{0.26}Mg_{0.41}Ti_{0.02})Σ=2.06(Si_{3.48}Al_{0.52})O₁₀(OH)₂ which shows slightly more than two M cations corresponding to 29.93/2.06=14.53 el for M2 and M3, 0.87 el for M1.

By optical microscopy a minor lamellar mica phase is observed within the matrix of phengite. These lamellae are of brown colour, uniaxial and in the same optical orientation of the matrix. The following crystal-chemical formula (K_{0.63}Ca_{0.01})(Al_{0.51}Fe_{0.76}Mg_{1.38}Ti_{0.09})Σ=2.65(Si_{3.18}Al_{0.82})O₁₀(OH)₂ is obtained from the data of an EDS electron-probe chemical analysis. Also taking into account the poor quality of the data, due to the very small dimensions of the lamellae, the brown sample shows phlogopitic composition.

An X-ray powder diffraction pattern on the natural sample confirms the presence of two trigonal phases with clearly different unit cells: a minor one (green phengite, a=5.214(4)Å, c=29.77(1)Å) and a major one (brown mica, a=5.28(1)Å, c=30.04(5)Å). All the brown lamellae examined by single-crystal X-ray diffraction showed trigonal symmetry, except for one resulting in a 1 M monoclinic polytype.

One can assume the following subsequent events took place: crystallization of 3T phengite at high P/T conditions; exsolution of iso-oriented 3T phlogopite within the phengite matrix; minor phase transition of the phlogopite from 3T to 1 M symmetry.

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SYNDEFORMLATIONAL REACTION OF PLAGIOCLASE AND OLIVINE IN EXPERIMENTALLY DEFORMED PLAGIOCLASE-OLIVINE AGGREGATES

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We investigated the effect of chemical disequilibrium on the deformation of plagioclase peridotite by performing simple shear deformation experiments on plagioclase-olivine mixtures at 900°C and confining pressures of 1.0 and 1.5 GPa.

In An₉₂-Fo₉₂ mixtures the applied confining pressures represent different degrees of overstepping on the mineral reactions Plg + Ol = Sp + Px and Plg + Ol = Gt + Px and produce chemical

reactions. An₆₀-Fo₉₂ mixtures, also used in experiments, are in chemical equilibrium at these confining pressures, and allow the study of crystal plastic deformation of non-reacting samples.

Mixtures of olivine(2):plagioclase(1) were prepared from 2-6 μm powders of Fo₉₂, An₉₂ and An₆₀. The mixtures were placed between dunite pistons, cut at 45 degrees to the compression direction. Prior to deformation, the samples were heated at 1000°C for 6 hours in a CO-CO₂ gas mixture and subsequently hot pressed for 24 hours at 0.7 GPa and 900°C. Our experiments were carried out in a Griggs apparatus under a constant strain rate of 5x10⁻⁵sec⁻¹.

In absence of reaction, An₆₀-Fo₉₂ and pure olivine samples show strain hardening with no yield up to stresses equal to the confining pressure.

Significant reaction induced weakening is observed in the An₉₂-Fo₉₂ samples deforming at lower stresses than pure olivine and unreacted samples.

The syndeformational reaction between An₉₂ and Fo₉₂ results in fine-grained (<1 μm) Ol-Sp-Gt-Px reaction products. These products form along An₉₂-Fo₉₂ grain contacts. They coalesce and accommodate most of the deformation by granular flow.

The mineral reaction is not observed in an undeformed An₉₂-Fo₉₂ sample, held hydrostatically at 900°C-1.5 GPa for the same duration as the deformation experiments.

Hence, the Fo₉₂-An₉₂ syndeformational reaction is enhanced by the deformation. The reaction itself is associated with a switch in deformation mechanism from crystal to granular flow of reaction products.

WATER DIFFUSION IN NATURAL OLIVINE AND SYNTHETIC FORSTERITE

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The interaction on upper mantle minerals with water is known to have a major influence of a range of physical and chemical properties. Thus, characterization of solubility and kinetics of incorporation for water in nominally anhydrous minerals is important in order to understand the behavior of Earth's deep interior. Experimental studies on the olivine-water system indicate that significant amounts of OH can dissolve within olivine as point defects (Bell and Rossman, 1992; Kohlstedt *et al.*, 1996; Kohlstedt and Mackwell, 1998).

Our study is based on hydrogenation of single-crystal samples by piston-cylinder and TZM cold-seal vessel experiments. We use FTIR analyses in order to constrain the speciation of the mobile water-derived defects in iron-bearing and iron-free olivine, and the rates of diffusion of such species under uppermost mantle conditions (0.2 to 1.5 GPa, 900 to 1100°C, 1 to 20 hours). Hydrogen defect transport in single crystals of olivine and forsterite is investigated for diffusion parallel to each crystallographic axis. Defect diffusivities are obtained by fitting a diffusion law to the OH content as a function of position in the sample.