

Textural evidence obtained from the CL images confirms that amazonite from the Morefield granite developed as a result of a post-magmatic replacement process. Aqueous fluids that were introduced along fractures and cleavage planes of the original primary tan-colored microcline, aided in the transformation to amazonite.

41-3 2:20 PM Nizamoff, James W.

PHOSPHATE MINERALOGY AND PARAGENESIS OF THE PALERMO #2 PEGMATITE, NORTH GROTON, NEW HAMPSHIRE
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 The Palermo #2 pegmatite in North Groton, New Hampshire is located in the Grafton pegmatite field of west-central New Hampshire. It is a rare-element pegmatite of the beryl-phosphate subtype which hosts a number of primary and secondary phosphate species. The primary phosphates triphylite, fluorapatite, hydroxylapatite and montebrasite occur mainly in the core margin. Late-stage, carbonate-bearing aqueous fluids have metasomatically altered these primary phosphates producing a diverse suite of nearly 40 species of secondary phosphate minerals and associated carbonates. Secondary phases related to the alteration of triphylite include: ferrisicklerite, heterosite, wofeite, rockbridgeite, beranuite, laueite, strunzite, vivianite, ludlamite, kryzhanovskite, jahnsite-(CaMnFe), jahnsite-(CaMnMn), stewartite, ushkovite, whitmoreite, chladenite, eosphorite, gormanite, messelite, fairfieldite, mitridatite, strengite and phosphosiderite. Secondary phases related to the alteration of montebrasite \pm hydroxylapatite/fluorapatite include: scorzalite, lazulite, paravauxite, gordonite, gormanite, souzalite, augeite, chlorapatite, whiteite-(MnFeMg), whiteite-(CaMnMg), jahnsite-(CaMnFe), jahnsite-(CaMnMn), crandalite, goyazite, chladenite, eosphorite, messelite, fairfieldite, collinsite and mitridatite. The substantial number of secondary phosphates at Palermo #2 is a result of alteration of both primary phosphates and associated silicate, carbonate, sulfide, arsenide and oxide minerals locally present in the core margin. Concomitant alteration of these associated minerals contributes the necessary ions to the hydrothermal fluids responsible for the formation of the diverse suite of secondary phosphates. Alteration of the mineral assemblage occurring in a given area creates a set of secondary phosphates characteristic of that specific assemblage, whereas a completely different set of secondary phosphates may appear only a few centimeters away. Thus, each suite of secondary phosphates is the product of its specific microenvironment of alteration.

41-4 2:35 PM Hatert, Frédéric

THE STABILITY OF ALLUAUDITE IN GRANITIC PEGMATITES
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 Alluaudite, a Na-Mn-Fe-bearing phosphate mineral, is known to occur in Li-rich granitic pegmatites. During the past decade, several compounds with the alluaudite structure were synthesized, but their stability was scarcely envisaged. Because alluaudite can occur as a primary phosphate in granitic pegmatites, we decided to investigate its stability. The hydrothermal synthesis were performed between 400 and 800°C at 0.1 GPa, using horizontally arranged Tuttle-type cold-seal bombs. The oxygen fugacity was controlled by the Ni-NiO buffer.
 Starting from chemical compositions corresponding to those of unoxidized alluaudites, Na₂(Mn, Fe²⁺)₂Fe³⁺(PO₄)₃, we obtained pure alluaudite at 400 and 500°C, whereas the association alluaudite + maricite appears between 500 and 700°C. The upper stability limit of alluaudite is defined by the crystallization of maricite, because this mineral has never been observed in granitic pegmatites. This limit corresponds to 550-600°C for Na₂Fe²⁺Fe³⁺(PO₄)₃, and to 450-500°C for Na₂MnFe²⁺Fe³⁺(PO₄)₃. At 800°C, alluaudite and maricite are associated with an undetermined phase ("X-phase"), whereas filowite crystallizes above 600°C, in the Mn-rich part of the diagram.
 Electron microprobe analyses of the synthesized phosphates were also performed, in order to establish phase relations in the central part of the Na-Mn-Fe (+PO₄) ternary diagram. When the temperature increases from 400 to 800°C, the composition of alluaudite shifts towards the Na-poor part of the diagram. This behavior is related to the crystallization of maricite, a phase richer in Na than alluaudite.
 Supplementary experiments were also performed in the Na-Li-Mn-Fe²⁺-Fe³⁺-P-O system, in order to better understand the stability limits of the alluaudite + triphylite paragenesis, which was observed in the Li-rich granitic pegmatites of Buranga, Kibingo (Rwanda), and Hagendorf-Süd (Germany). Below 600°C, alluaudite is associated with triphylite, whereas maricite appears between 600 and 700°C. At 800°C, "X-phase" crystallizes together with triphylite. The upper stability limit of the alluaudite + triphylite paragenesis, without maricite, corresponds to 600°C, a temperature which is in good agreement with the conditions generally considered to occur in granitic pegmatites.

41-5 2:50 PM Grew, Edward S.

DIVERSE BOROSILICATE ASSEMBLAGES IN ANATECTIC GRANITIC PEGMATITES CUTTING BORON-RICH GRANULITE-FACIES ROCKS OF THE LARSEMANN HILLS, PRYDZ BAY, EAST ANTARCTICA
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 In the great majority of granitic pegmatites boron is localized exclusively in minerals of the tourmaline group. This is not the case in the Larsemann Hills, where 5 borosilicate minerals appear to be primary phases in granitic pegmatites derived from anatectis of granulite-facies (~7 kbar; ~800-850°C) metasediments and metavolcanogenic rocks. The metamorphic rocks comprise several mappable boron-rich units: (1) biotite plagioclase gneiss with pods of prismatic + cordierite + biotite +/- tourmaline +/- orthopyroxene + minor grandierite; (2) leucocratic sillimanitic gneiss with abundant grandierite and prismatic and subordinate tourmaline; and tourmaline metaquartzite. There are two generations of boron-enriched pegmatites: (1) roughly concordant, but locally crosscutting, irregular pods up to 1 m thick (D2-D3 pegmatites) often spatially associated with prismatic-bearing pods and (2) planar veinlets (D4 pegmatites) cutting D2 and D3 structures and not necessarily associated with rocks containing borosilicate. A distinctive feature of both generations of pegmatite is a graphic intergrowth up to 30 cm across of schorl-draive grains in polygranular quartz. Other borosilicates presumed to be primary are the ferromagnesian minerals prismatic and grandierite as well as two Al-rich minerals: pale purple, titanian dumortierite (3.7-5.0 wt% TiO₂) in parallel prisms in quartz, and boralsilite, an acicular mineral resembling sillimanite, often in fans, in quartz and microcline near the graphic intergrowths. Boralsilite ranges in composition from Al₁₆O₈B₅Si₂1.037 to Al₁₅8Mg₀2Fe₀4B₄9Si₂7O₃₇, i.e., it contains 0 to 30% of a weringite component. It is not found with prismatic or cordierite. Secondary phases include bright-blue, highly pleochroic Ti-poor dumortierite, highly zoned blue foilite-schorl, and andalusite. We attribute the diversity of primary borosilicate minerals to extreme boron enrichment of the pegmatites during anatectis and to minimal loss of boron to wallrocks during crystallization, probably because relatively little fluid was present. Temperatures were sufficiently high and water activities sufficiently low to stabilize not only Al₂SiO₅ + K-feldspar in lieu of muscovite, but also boralsilite with substantial weringite in solid solution.

41-6 3:05 PM Hartwick, Emily E.

CRYSTALLIZATION CONDITIONS AND FLUID CHEMISTRY OF THE ANIMIKIE RED ACE PEGMATITE, FLORENCE COUNTY, WISCONSIN
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The Animikie Red Ace (ARA) pegmatite is the largest of ~200 pegmatites exposed in the LCT-type Hoskin Lake pegmatite field of Florence County, WI, which is thought to be related to post-Penokean (~1.760 Ga) granitic magmatism. The ARA pegmatite is a zoned, lithium-rich pegmatite, remarkable for raspberry-red-tourmaline-rich wall zones. It is one of four known occurrences of offhodite-londonite in the world (K, Cs, Al, Be borate). The Hoskin Lake pegmatites are somewhat similar to the gem-bearing, miarolitic (pocket) pegmatites of San Diego County, CA, because of their distribution in thin, sub-parallel layered dikes, the abundance of colored tourmaline, and comparable pressures of emplacement (~2-4 kbars). However, to date, neither pockets, norgem-quality crystals have been reported in the Hoskin Lake pegmatites.

This fluid inclusion study integrates microthermometry and crush-leach analysis to evaluate the magmatic fluid chemistry and crystallization conditions of the ARA pegmatite in comparison to results from other pocket and non-pocket lithium-rich pegmatites. Microthermometric data were collected from zoned tourmalines. The primary fluids are H₂O-CO₂ mixtures with an average X_{CO₂} of 0.09 ± 0.03, salinities of 6.5 ± 1.2 wt% NaCl_{eq}, and trapping temperatures of 407 ± 25°C (at a pressure of 3 kbar). The primary magmatic character of H₂O-CO₂ inclusions in tourmaline was inferred based on their distribution relative to crystal growth zones. The low crystallization temperatures are comparable to values reported for other lithium-rich pegmatites, and may be due to high concentration of fluxes such as B, P, alkalis and water, or to high degrees of undercooling.

The leached analyses indicate that atomic ratios F/Cl (0.02-0.08) and Li/Na (0.01-0.08) of the ARA fluids vary systematically from pegmatite's wall zones to its core. These values overlap with fluid ratios measured from non-pocket pegmatites including Tin Mountain (Black Hills, SD) and Palermo (Grafton, NH), but are lower by an average factor of 7 and 4, respectively, than ratios measured in pocket, gem pegmatites (San Diego, CA). These preliminary comparative results suggest that 1) the ARA does not contain pocket gems and 2) the chemistry of major and minor ions of fluid inclusions is a potentially useful tool in gem-pegmatite exploration.

41-7 3:20 PM Linnen, Robert L.

FERROCOLUMBITE-MANGANOTANTALITE TRENDS IN GRANITES AND PEGMATITES: EXPERIMENTAL AND NATURAL CONSTRAINTS
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It has long been recognized that the chemical compositions of columbite-tantalite record fractionation trends in granites and granitic pegmatites, from more primitive ferrocolumbite to highly fractionated manganotantalite (e.g. Cerny et al., 1986). The solubility experiments of Linnen and Keppler (1997) explained why Nb/Ta decreases with fractionation, but Mn/Fe trends in natural columbitites are more complex, and remain poorly understood. To clarify this, the solubilities of FeNb₂O₆ and FeTa₂O₆ have been determined at 800°C, 200 MPa and fO₂ near Ni-NiO for the 200 MPa haplogranitic minimum melt composition (ASI=1.0). These values are ~1x10⁻³ and 2x10⁻³ mol/kg, respectively, which are roughly an order of magnitude greater than those of the Mn end-members at the same conditions. The lower solubilities of the Mn end-members indicate that columbite crystallization should result in a decrease of the Mn/Fe ratio of the residual melt. This is the opposite of most natural trends, indicating that columbite-tantalite crystallization does not control the Mn/Fe ratios in highly evolved granitic melts. The Mn-Fe compositions of columbite-tantalite reflect, in part, the control of Mn-Fe concentration in the melt by the crystallization of other phases. Crystallization of garnet should result in a decrease of the Mn/Fe ratio in the residual melt whereas the crystallization of tourmaline and muscovite should result in an increase of the Mn/Fe ratio in the residual melt. Inflections in columbite-tantalite composition trends are likely related changes of phases on the liquidus.

41-8 3:55 PM Hanson, Sarah L.

SAMARSKITE-(Yb): A NEW MINERAL INDICATING EXTREME HREE ENRICHMENT IN THE SOUTH PLATTE NYF PEGMATITE DISTRICT, COLORADO
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The South Platte Pegmatite district, located in Jefferson County, Colorado is hosted within the 1.0 Ga Pikes Peak batholith. These pegmatites are noted for their strong enrichment in rare earth elements (REE), Nb, Y, and F. Within the district, a geographical separation exists between pegmatites enriched in light REE (LREE) versus those enriched in heavy REE (HREE). Composite core pegmatites in the southern part of the district contain large masses of allanite-(Ce) and are LREE enriched. Quartz core pegmatites, located in the northern portion of the district, have only minor allanite-(Ce), but contain large radiating nodules of samarskite "group" minerals up to 30 cm in diameter. The samarskite "group" species occur in albite-rich, core-margin replacement units associated with HREE-rich zircon (cyrtoite), ferrocolumbite, monazite-(Ce) and yttrian fluorite. This "samarskite" has elevated HREE content compared to "samarskite" from other pegmatites (e.g. Kunar, Afghanistan, Spinelli, CT, Spruce Pine, NC, and Oxford, ME). Its Y content, however, is equivalent. Such strong HREE enrichment of nearly an order of magnitude is sufficiently high that numerous samples have Yb>Y. These Yb-dominant samples are the new mineral, samarskite-(Yb), recently approved by the CNMNM (# 2004-001).

The separation of LREE and HREE enriched minerals into separate pegmatite groups is related to late-stage enrichment of F and other volatiles into the upper portion of the pluton and to selective complexing of HREE with F. Thus, HREE, which more readily form complexes with F, were preferentially partitioned into the F-rich upper portion of the pluton. The pegmatitic melts evolved from subsequent fractionation of this volatile-rich upper portion. The HREE in the pegmatitic melts remain complexed with F until F begins to be removed by the formation of F-bearing minerals such as fluorite. Samarskite-(Yb) and other HREE minerals then begin to form in the very final stages of crystallization, typically in replacement units.

41-9 4:10 PM Wise, Michael

EVOLUTION OF ZIRCON CRYSTALLIZATION FROM THE BLACK MOUNTAIN PEGMATITE, MAINE

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Zircon is present in 4 of 5 primary zones and the cleavelandite-rich replacement unit of the complex, Li-enriched Black Mountain granitic pegmatite. Textural evidence indicates that zircon underwent a complex growth history that included magmatic crystallization, radiation-induced fracturing, late-stage subsolidus alteration, and recrystallization. Primary zircon is characterized by Hf-enriched, U-poor compositions along with the presence of coarse-grained uraninite