visible under the SFEG-SEM. Calcite formation is observed immediately after a pure vaterite is added to water. Synchronous nucleation at many different sites was observed. The observation that crystal growth was not effected by changes in stirring speed confirms that diffusion did not limit crystal growth. On the hand the powder initially already containing calcite transforms by growth of a few bigger sized crystals. The impact of differences in stirring speed on the transformation rate can be explained by diffusion limited growth of a restricted number of bigger crystals, i.e. less nucleation sites available. Due to Oswald Ripening smaller crystals will eventually disappear and the final morphology of both solids will look similar. However, the different kinetics be explained only by following the change in morphology during the complete transformation process. All evidence of different transformation pathways gets lost as the morphology of the solids before and after transformation is nearly identical.

V51H-0389 0830h POSTER

Source Signature of Sr Isotopes in Fluids Emitting From Mud volcanoes in Taiwan

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Located at the boundary between the Philippine Sea Plate and the Asia Continental Plate, abundance of mud volcanoes were erupted on land in Taiwan. According to their occurrences and associated tectonic settings, these mud volcanoes were classified into four groupies. The group (I) mud volcanoes are located in the western coastal plane, whereas group (II) and (III) are situated near the Kutinkung anticline axis and the Chishan fault respectively. The group (IV) mud volcanoes are discovered at the Coastal Range. Although there are numerous studies focused on morphology, possible fluid migration paths and sources are poorly understood. We have collected and analyzed major ions and Sr isotopic ratios in fluids separated from various mud volcanoes in Taiwan. Chemical contents of these fluids were measured by IC and the emitted gasses were analyzed by GC. The Sr concentrations in these fluids were determined using AA and the isotopic compositions were analyzed by TIMS. The dominated ions in fluids are Na and Cl which account for 98% of dissolved materials. All fluids show similar Na/Cl ratios(0.7-0.8), slightly higher than seawater but each group has unique Sr isotopic signature. Waters expelled from group I mud volcanoes featured with low salinity and high Sr isotopic ratios ranged from 0.71150 to 0.71175. Groups II and III were outcroped in the Kutinkung formation but show distinctive chemical compositions. Group II fluids have four times Cl concentrations(358-522mM) compared with those of group III(85-162mM). The latter fluids appear to be more radiogenic(0.71012- 0.71075) indicating possible influence due to water-rock interactions. Low $^{87}Sr/^{86}Sr$(0.70692-0.70939) is typical characteristic of mud volcano fluids in group IV where large Mg and K depletion were discovered, suggesting effects due to sediment diagenetic processes. The chemical compositions of mud volcano associated gasses show similar distribution pattern. The major gas constituents in mud volcano zones II and III are methane(>80%), air(1-10%) and carbon dioxide(1-5%). Gases collected from zone IV display significantly higher air content(5-20%) with low carbon dioxide(<0.2%). These results are useful for gaining a better understanding of mud volcano fluid sources.

V51I MCC: Level 1 Friday 0830h

Intrusions and Ore Deposits Posters

Presiding: **A E Boudreau,** Duke University**; J S Miller,** San Jose State University

V51I-0390 0830h POSTER

Vapor Separation and Migration in a Solidifying and Compacting Crystal Pile

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The effect of vapor separation and migration in a crystal pile undergoing simultaneous crystallization and compaction has been investigated using a modified version of the IRIDIUM program. This program incorporates a simplified version of the MELTS program of Ghiorso and others coupled with compaction-driven thermal and mass transfer based on the works of Mckenzie and Shirley. The program also allows for trace-element modeling. The program has been modified to allow the independent upward migration of a separate vapor phase. It also now incorporates a COHS gas phase and sulfide phases. The solidification of a crystal + liquid assemblage that is loosing heat out the bottom results in the eventual separation of a volatile-rich fluid or vapor. The vapor separated from cooler parts of the crystal pile migrates upward to hotter assemblages and redissolves in the interstitial liquid that has not reached vapor saturation. This influx of volatiles results in a remelting of the solids, producing a liquid-rich zone within the crystal pile. This liquid-rich zone migrates upward with time, and mimics a zone-refining metallurgical process. If the remelting zone approaches the top of the crystal pile, the effect is a relatively sharp transition from liquid-rich to liquid-poor assemblages. After the zone has passed any given horizon, major mineral compositions are relatively unaffected (e.g., there is no readily apparent change in mg# or mineral porportions). However, vapor-soluble elements are moved upward over time. In the case of sulfur, this can result in the upward migration of a sulfide-saturation zone with time. The remelting of pre-existing solids may lead to zones of instability within the crystal pile. Examples of slumping, shearing and layer disruption from the Stillwater Complex are shown that may have been caused by such a process.

V51I-0391 0830h POSTER

Tungsten Mineralization Associated With Granitoid Rocks in Southwest of Arak, Iran

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The NezamAbad-Malmir intrusion is located 45 km southwest of Shazand, Arak. It is trending southeast-northwest and is a part of the Sanandaj-Sirjan zone of the metamorphic belt of Iran. The intrusion is composed of some huge composite bodies with an area of 180-200 km^2. It is related to Alpine orogeny and intrudes metasediments of upper Triassic-Jurassic. The latter rocks consist of phyllites, micaschists, quartzites, metamorphosed cherty limestones and metamorphic acidic and basic tuffs. Two types of tungsten mineralization accompany the NezamAbad-Malmir intrusion: 1. Stratabound type, 2. Quartz-tourmaline vein type. Stratabound type is seen at Bamsar. In this area, six ore-bearing horizons have been identified. Country rocks are mainly calcareous schists in which ore minerals occur in laminas and layers. Ore paragenesis includes scheelite, chalcopyrite, arsenopyrite, sphalerite, pyrite, cassiterite, chalcocite and covellite. Vein type mineralization is hosted by tonalite-quartzdiorite intrusions at Revesht, NezamAbad and Fizaneh that are located 3, 7 & 8 km away from Bamsar. Ore paragenesis in these mineralized tourmaline and quartz veins consists of euhedral to anhedral scheelite and chalcopyrite. The NezamAbad-Malmir intrusion shows a range in composition from tonalite to alkali-granite. These plutons are texturally medium-grained granular but include some porphyritic textures. In thin section, the granophyre and myrmekite are observed. Pegmatite-aplite veins and dykes are fairly abundant. XRF analyses for 2 aplites (near tungsten mineralization) and a pegmatite sample show 3, 8 and 23 ppm tungsten, respectively. The tungsten content of the intrusion samples range from 15 to 45 ppm. The rock sample with the highest tungsten content (45 ppm), is a tonalite situated near the contact with metasediments. It is suggested that at Revesht, NezamAbad and Fizaneh, the NezamAbad-Malmir intrusion provided the tungsten deposited in quartz-tourmaline veins. The Bamsar occurrence is however, sedimentary-diagenetic in origin, subsequent concentration happening through Late Kimmerian regional metamorphism and deformation.

V51I-0392 0830h POSTER

Absence of Cryptic Zonation in Modally zoned Granitic Pegmatites: Petrogenetic Implications

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The Evje-Iveland and the Froland granitic pegmatite fields in South Norway share many similarities and are nearly indistinguishable in terms of their mineralogy, radiogenic isotope signature and accessory mineral assemblage. Both fields comprise REE-Nb-Ta type pegmatites with overlapping Mesoproterozoic ages close to 900 Ma and low 87Sr/86Sr ratios of only 0.7062-0.7064. However, a recent study of the REE distribution in K-feldspar (Larsen, 2002, The Canadian Mineralogist, 40, 137-151) unequivocally demonstrates that the parent melts forming the two pegmatite fields were derived from different source regions. The trace and major element distribution in feldspar follows well defined igneous trajectories during igneous evolution of the granitic melts from typical K/Rb ratios in perthite of 360 in the most primitive pegmatites to 100 at the most evolved localities. Altogether the pegmatites in both fields feature a well-defined igneous evolution from primitive to progressively more evolved compositions. The individual pegmatites are modally zoned from the margin towards the interior. The wall zone is dominated by plagioclase and perthite, accessory biotite and muscovite, and quartz. The intermediate zone (IZ) comprises metre size crystals of biotite, perthite, plagioclase, quartz and minor muscovite. The core-zone (CZ) features rafts of perthite and minor plagioclase in large masses of quartz. Given this well-defined modal zonation and the regional igneous evolution, it would be expected that the major minerals feature a cryptic zonation from relatively primitive compositions in wall zone to more evolved compositions in the core-zone. However, sampling and analysis of perthite from IZ to CZ from 20 pegmatites failed to confirm the presence of a cryptic zonation when comparing the major and minor element compositions. Key element ratios including the K/Rb, Sr/Rb, Eu/Rb and the LREE/HREE ratios that all are supposed to decrease from IZ to CZ mostly remained unchanged or were increasing. Similar to perthite, the trace element distribution in quartz change systematically from primitive to progressively more evolved pegmatites throughout the pegmatite fields. However, the analysis of trace elements in quartz from 120 localities also failed to document systematic changes in key trace element ratios (e.g. the Ti/Ge ratio) from the margin towards the interior of individual pegmatites. The absence of a cryptic zonation of major minerals from contact to core in the otherwise modally zoned granitic pegmatites is a challenge to normal petrogenetic models. Some possible models that will be discussed at the AGU 2003 Fall Meeting are: A) The modally distinctive zones of the granitic pegmatites solidify simultaneously in compositionally distinctive domains that may be maintained by double diffusive convection cells. B) Following a recent proposal by M. Taylor, the hydrous pegmatite melts transform into gels upon emplacement or during crystallization. Gels facilitate the evolution of large modally distinctive domains that crystallize simultaneously (Taylor M., 18th IMA Meet. 2002, Prog. Abstr. P. 260).

V51I-0393 0830h POSTER

Preliminary Experimental Results on Phase Relations in the PbS-$AgSbS_2$-$AgBiS_2$ Ternary

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The presence of significant solid-solution of silver sulfosalts in galena in the PbS (galena)-$AgSbS_2$(miargyrite)-$AgBiS_2$ (matildite) ternary system suggests that ore in many important silver deposits may have been formed by retrograde unmixing of higher-temperature silver-bearing galena solid solution. We present results of evacuated silica capsule experiments designed to constrain the extent of Ag solid solution in galena and other important phase relations in this system over a range of temperatures relevant to ore formation. Experimentally-based phase diagrams in the $AgSbS_2$-PbS, $AgSbS_2$-$AgBiS_2$, and $AgBiS_2$-PbS binaries indicate complete solid solution above 420°C. If these phase diagrams are correct and the topological features can be extended into the supersystem, they would imply that the galena structure (Fm-3m) extends across most or all of the ternary at high temperatures. Below 420°C, a miscibility gap is observed on the $AgSbS_2$-PbS binary, approximately midway between the freieslebenite ($PbAgSbS_3$) and galena compositions. New experimental data indicate that this miscibility gap on the $AgSbS_2$-PbS binary extends well into the ternary. This miscibility gap appears to close at $X_{PbS} > 0.60$ and $X_{AgBiS2} > 0.12$ at about 350°C, and $X_{PbS} > 0.65$ and X_{AgBiS2}

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$\leq$ 0.06 at 400°C. One experimentally determined tie line at 350°C has equilibrium compositions of about X_{PbS} = 0.823, X_{AgBiS2} = 0.087, X_{AgSbS2} = 0.090 and X_{PbS} = 0.578, X_{AgBiS2} = 0.145, X_{AgSbS2} = 0.277. The presumption that the galena (Fm-3m) structure extends across the $AgSbS_2$-PbS binary at temperatures above 380°C has not been established conclusively. If a single Fm-3m phase exits, it is extremely difficult to model the observed off-centered miscibility gap between $AgSbS_2$ and PbS using simple regular-solution theory. Alternatively, the observed miscibility gap may separate an Fm-3m phase on the galena side from a related, probably derivative, structure on the $AgSbS_2$ side. This second structure may reflect ordering of Ag^+ and Sb^{3+} (Bi^{3+}) on cation sites. The alternate interpretation would imply a phase boundary extending from the miscibility gap possibly to the solidus, and would be expected to have significant influence on phase diagram topology and thermodynamic modeling in this system. Constraints on viable phase relations will be discussed along with preliminary models for relevant phases. Because many candidate symmetry transitions can be expected to be unquenchable, complete solution of this problem may require high-temperature calorimetry and in situ high-temperature x-ray structural refinements. Related issues in other parts of the ternary will also be discussed.

V51I-0394 0830h POSTER

Mineralogical and Fluid Inclusion Studies of the Yugeum Hydrothermal Gold Deposit, Youngdeok Area, Korea

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The Yugeum gold deposit occurs as quartz veins within Jurassic sedimentary rocks and Cretaceous granite in Gyeongsang Basin located in the southeastern region of the Korean peninsular. Cretaceous Younghae granites are intruding and underlying the Gyeongsang basin near the study area. Gold-bearing quartz veins filling the fracture with a direction of N18.5°- 38W° are most abundantly distributed in Younghae granites. During the gold mineralization, hydrothermal fluids precipitated abundant sulfide minerals in quartz veins including pyrite, chalcopyrite, galena, sphalerite and arsenopyrite. Gold commonly formed fine-grained electrums in sulfides which has a characteristic of high Au contents (up to 92 wt. per cent). Fluid inclusions from quartz veins commonly contain CO2 in various concentrations, although Liquid-Vapor type inclusions are also observed. Fluid inclusions from the quartz related to the major gold mineralization homogenize over a temperature range from 290° to 350°C with salinities from 2.6 to 7.0 wt. per cent NaCl equivalent. Log f (S2) of the ore fluid in this condition is estimated near 7.3 and the dominant species of gold transport in the ore fluids is considered as the complex Au(HS)2-. Based on the fluid inclusion data, the decrease of pressure as well as temperature in the fluid have caused the decrease of sulfide solubility and resulted the precipitation of gold-bearing sulfides in the area.

V51I-0395 0830h POSTER

Mass-Dependent Molybdenum Isotopic Variations in Molybdenites Determined by MC-ICP-MS

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We have developed analytical techniques for the measurement of mass-dependent molybdenum isotopic variations in geological materials using a Nu Instruments plasma ionization mass spectrometer. Our methods are modified from the procedures developed by Barling et al. (2001; EPSL; v. 171) using Zr as an external inter-element monitor of instrumental mass bias. For the chemical separation and purification of Mo, we use a low blank, high yield (>98%) two-column procedure to maximize the removal of matrix elements and reduce the chromatographic fractionation of Mo. The effect of the solution Mo/Zr upon the measured Mo isotope ratios was evaluated by analyzing solutions with a range of Mo/Zr. Matrix effects due to Zr were significant at low Mo/Zr (up to an $0.8^o/_{oo}$range for 97Mo/95Mo), but were negligible for the high Mo/Zr that we used for our analyses. Matrix effects for a number of other elements (Na, Mg, Nb, Cd, Sb, W, and Tl) were evaluated and found to be below detection even for extremely high amounts, except for Mg. In this case, matrix effects on the Mo isotope ratios were not observed at Mg/Mo below 0.015, which is at least a factor of 3 higher than typical samples. In contrast, chromatographic fractionation of Mo was found to be significant. The 97Mo/95Mo of the Mo eluted from the first column in small cuts varied by a range of $2^o/_{oo}$. However, this effect was negligible ($<0.05^o/_{oo}$) for yields greater than 96%. The precision and accuracy of three different mass bias corrections were evaluated using analyses of synthetic Mo solutions: the "graphical" (Marechal et al., 1999; Chem. Geol.; v. 156) and the "inter-element" methods using Zr to correct the Mo isotopic ratios for mass bias, and a simple sample-standard bracketing approach that ignores the presence of Zr. All three methods gave similar accuracy, but the last approach was found to give a superior precision by a factor of 2 (typically $0.15^o/_{oo}$, 2 sigma, on 97Mo/95Mo). Five molybdenites that formed under a range of redox conditions were analyzed using this procedure. They display a total 97Mo/95Mo range of $1.4^o/_{oo}$, which is significantly larger than the $0.4^o/_{oo}$range found in a previous study of molybdenites (Barling et al., 2001). More detailed studies are required to determine the origin of these mass-dependent isotopic variations of Mo.

V51I-0396 0830h POSTER

Retrograde Evolution of the Hemlo Gold Deposit, Ontario: Fractional Crystallization of a Sulfide Melt and Remobilization of Ore-Related Metals

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The Hemlo gold deposit is a greenstone-hosted, lode-gold system in north-central Ontario, Canada. The main stage of gold mineralization occurred prior to peak, amphibolite-facies metamorphism, and is characterized by disseminated Au-Mo in potassically altered, barite- and pyrite-rich schists. Locally extensive remobilization of this ore occurred at or immediately after peak metamorphism (~630°C, 5-6 kb), and is represented by minerals such as stibnite, realgar, orpiment, zinkenite and cinnabar, which are unstable at high temperature. Volumetrically minor gold was subsequently precipitated in calc-silicate zones at ~400°C. Minerals reflecting early remobilization occur either at grain boundaries or as solid inclusions along healed fractures devoid of fluid inclusions. Planes of solid inclusions, many of which are polyphase, radiate locally from the boundaries of large polyphase sulfide aggregates. Inclusions containing both liquid and sulfides are observed mainly at intersections of planes of solid-only and liquid-vapor inclusions. Solid inclusions are characterized by complex assemblages in the system As-Sb-Pb-S, that reflect contrasting conditions of fS_2 and fO_2. The low thermal stability of many of these minerals, the absence of liquid in the solid inclusion trails, the excessive hydrothermal solubility of stibnite above 300°C, and the evidence of contrasting fS_2 and fO_2 rule out hydrothermal processes as the cause of this remobilization. We therefore propose that the latter was the result of formation of an As-Sb-Pb-S melt, at or near peak metamorphic conditions, containing minor proportions of Au, Hg, Ag, Cu, Tl and Te, and support this hypothesis with results of preliminary experiments showing that realgar-stibnite-cinnabar-bearing solids homogenize to liquid at ~435°C. The melt is envisaged to have formed as a result of exsolution of elements such as As, Sb and Au from arsenian pyrite during metamorphic recrystallization, melting of primary sulfosalts, and interaction of both with hydrothermal fluids of metamorphic origin carrying barite-derived sulfur. Additional gold was derived by local melting of primary Hg-bearing native gold. Finally, we explain the diversity of the sulphide assemblages as being the result of cooling-induced fractional crystallization involving early precipitation of Sb and Pb-bearing minerals, which progressively enriched the remaining melt in As until realgar and orpiment started to deposit at a temperature of ~300°C.

V51I-0397 0830h POSTER

Magmatic construction and duration of solidification of Searchlight pluton, Eldorado Mountains, Nevada (USA)

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The process of chamber construction and the residence time of magma in mid- to upper crustal magma bodies have been illuminated by recent advances in high-resolution geochronology. Most work has so far concentrated on young volcanic systems; few geochrononlogic data have addressed magma chamber longevity and history from studying plutons. Plutons offer an important complementary record of magma processing and solidification, and can therefore reveal much about the internal workings of magma chambers. The Miocene Searchlight pluton (Nevada, USA) is a spectacular example of a very thick magma chamber (10-12 km). Crystal accumulation (mafic quartz monzonite cumulate), coupled with roof-down solidification (upper quartz monzonite) resulted in segregation of evolved felsic melt in the chamber interior (middle granite). Initially horizontal and gradational internal contacts and coplanar magmatic fabrics between all major units, geochemical mass balance, and very limited isotopic variation among major units, suggest that the entire pluton was molten at one time. However, the time inteval over which the chamber solidified was not well known. New TIMS and *in situ* ion microprobe U/Pb dating of zircon, combined with our earlier and ongoing field and isotopic studies, now appear to document a protracted magma chamber history. TIMS and ion microprobe dating (Stanford/USGS SHRIMP-RG) was done on two samples, and a third sample was dated by ion microprobe only. A multi-grain, multi-fraction discordia lower intercept age of 16.7±0.5 Ma (MSWD=22) was obtained by TIMS from the lower mafic quartz monzonite cumulate. Ion probe dating of zircons from the same sample yielded a $^{206}Pb/^{238}U$ age of 16.9±0.2 Ma (MSWD=1.3; N=24) in agreement with the TIMS lower intercept age. A discordia lower intercept age of 15.7±0.4 Ma (MSWD=3.7, one concordant point at 15.8 Ma) was obtained from the middle granite unit. Ion probe dating of zircons from the same sample yielded a $^{206}Pb/^{238}U$ age of 16.2±0.2 (MSWD=3.5; N=28). Distinct $^{206}Pb/^{238}U$ age maxima at 16.8 Ma for the lower cumulate unit and 15.8 Ma for the middle granite are also apparent on cumulative age-probability plots. Ion probe dating of zircons from a third sample of fine-grained quartz monzonite near the roof yielded a $^{206}Pb/^{238}U$ age of 16.0±0.3 (MSWD=1.4; N=20) with a broad cumulative age probability maximum at 16.2 Ma. High MSWD of the discordia for the TIMS data are attributable to Proterozoic inheritance but are well-anchored at the lower intercepts. Proterozoic cores are occasionally found during ion probe analysis but these are not included in the ion probe ages. The age results taken together argue for 700,000 to 1 million years of separation between crystallization of the oldest and youngest zircons in the Searchlight magma chamber. Although melts may have been added to the chamber incrementally from deeper sources, the new age data above are consistent with all other data and observations, which indicate protracted magma residence and monotonic solidification and fractionation from relatively uniform trachydacite magma.

V51I-0398 0830h POSTER

Mafic injection and local hybridization in a nearly frozen magma chamber: failed (?) rejuvenation in the Searchlight pluton, Eldorado Mountains, Nevada (USA)

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The Miocene Searchlight pluton (Nevada, USA) is a well-exposed, 12 km thick magma chamber. Previous work indicates it solidified in simple monotonic fashion. Crystal accumulation on the chamber floor, and downward propagation of a solidification front from the roof, resulted in felsic melt segregation in the interior. However, one small (3 km^2) relatively mafic part of the pluton (called Guzzler Gulch) has abundant chemical and textural variation at a scale not observed elsewhere in Searchlight pluton (cm to m). This unit intrudes through the gradation between the lower cumulate and the middle granite. The main rock type is an equigranular hornblende diorite, but fine-grained hornblende gabbro is also common. Contacts of mafic rocks with surrounding granite are gradational, and mutually crosscutting relations are seen where gabbros and diorites intrude granite and are back-veined by granitic dikes. Later gabbros are also seen cutting earlier gabbros. A number of observations suggest that the mafic injections occurred when the Searchlight magma chamber was waning: (1) Guzzler Gulch unit is intruded into granite that is at least partly cumulate, (high modal alkali feldspar displaying originally horizontal layering); (2) inclusions of the feldspar-rich, cumulate granite, up to 5 m in diameter, are completely surrounded by hornblende diorite, and are inferred to be autostoped blocks of mostly solidified granite; (3) irregular-shaped gabbroic pods several m's in diameter are also intruded into the cumulate granite, but hybrid zones are narrow (a few m's), and consist of heterogeneous light and dark banded rocks with abundant mafic enclaves; (4) the originally horizontal cumulate fabric in the granite is locally disrupted by, and sometimes reoriented, into parallelism with the contact between the Guzzler Gulch mass and the surrounding granite; (5) geochemical data are consistent with local hybridization, but hybrids are chemically quite heterogeneous on the scale of the entire Guzzler Gulch body; (6) Ion-microprobe $^{206}Pb/^{238}U$ zircon ages from a hybrid diorite and a coarse-grained gabbro are 16.2±0.2 Ma (MSWD = 2.7; N=17) and 15.9±0.3 (MSWD = 2.2; N=19), respectively, which overlap within error the 15.8±0.4 Ma zircon age of the late-crystallizing middle granite unit of the main Searchlight pluton. The Guzzler Gulch area of the Searchlight pluton appears to capture the process of failed rejuvenation of an intermediate to felsic magma chamber that was nearly solid. Physical evidence for physical disruption of crystal-rich, or even near-solidus magma by repeated mafic input (e.g. autostoping and engulfment of cumulate blocks) was accompanied by quite localized remelting of mush and/or reheating of the felsic cumulates and spatially restricted hybridization. Thus during the time of intrusion of the Guzzler Gulch mass, the Searchlight magma chamber was incapable of thorough mixing.

V51I-0399 0830h POSTER

Au-Skarn Mineralization: Constraints from LA-ICP-MS U-Pb Zircon Dating

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In situ U-Pb zircon geochronology by laser ablation ICP-MS was performed on samples from the intrusive rocks of the Buckhorn Mountain, Washington in order to constrain the age of the Crown Jewel Au-skarn deposit. The analyses were conducted at Washington State University using a ThermoFinnigan Element2 single collector, high resolution magnetic sector ICP-MS, and a New Wave UP 213 Nd-YAG (213 nm) laser ablation system. The analytical parameters included a repetition rate of 10 Hz, a 40 microns spot size, and a total analysis time of 30 seconds per spot. A 94-35 cascade standard was used to bracket the samples. Two distinct $^{206}Pb/^{238}$ U ages were obtained, 52.3 Ma ± 1.6, 165.0 Ma ± 5.9, 163.4 ± 5.7, and 169.8 ± 12.1 (all errors are 2 sigma). These ages represent distinct magmatic events occuring during the two main tectonic periods in the region. The oldest age (∼165 Ma) is associated with the accretion of the Quesnel terrain during the Middle Jurassic while the younger age (∼52 Ma) represents the magmatism during the Eocene extension that is well represented by the Challis Volcanics in the vicinity. The Jurassic ages were obtained in one sample from a deformed granodiorite dike and two samples from the main granodiorite intrusive facies that, based on the skarn mineralogy zonation, is spatially associated with the skarn. The Eocene intrusive unit was intercepted in one drill core but is clearly distinct from the granodiorites both geochemically and mineralogically. This facies is more an adamellite, with a distinctive pinkish colour due to a K-spar alteration. It is higher in silica, and depleted in compatible elements (Ca, Fe, Ti, Mg, P, Y, and V) relative to the granodiorite. Geochemically the granodiorite has a composition typical of plutons associated with Au-skarns worldwide. Because Au mineralization is erratically distributed and does not correlate with any of the skarn mineralogy, a question can be raised. Does the Au mineralization have any connection with the more recent intrusive event? Future work will be conducted in order to clarify this question.

V51J MCC: Level 1 Friday 0830h

The Changing Shapes of Active Volcanoes: Volcano Geodesy I Posters

(joint with G)

Presiding: **M P Poland,** U.S. Geological Survey

V51J-0400 0830h POSTER

Analysis of mud volcanoes on the Absheron Peninsula, Azerbaijan using InSAR

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A set of Synthetic Aperture Radar data covering the Absheron Peninsula is processed using interferometry (InSAR) to generate a detailed digital elevation map of the region and to measure possible surface deformations. The dataset includes five ERS-1 and ERS-2 scenes from 1996 though 1999 centered near Baku and 8 Radarsat images from 1999. The radar has a wavelength of 5.66 cm allowing theoretical resolution along the line of sight of the satellite of surface deformations on the order of mm to cm. Sources of potential surface deformation are recent earthquakes, mud volcanism, groundwater changes, and hydrocarbon withdrawal. We also use optical satellite images (Advanced Spaceborne Thermal Emission and Reflection - ASTER) in addition to ground truth data. Initial InSAR processing used a digital elevation model (DEM) based on the combination of a global DEM with a high resolution DEM based on ASTER stereo optical data. This DEM was then refined with radar pairs possessing short temporal baselines. Correlation over the area was fair with moderate to low correlation over a time period of 2 years. Preliminary results using the initial DEM show no clear indications (> 10 cm line-of-sight) of deformation over known mud volcanoes. Modeling of likely fluid movement associated with the mud volcanoes indicates that the lack of observed signal places constraints on the depth of increased pressure and chamber size. Modeling of the two large (Mw 6.8 and 6.5) earthquakes near Baku in November 2000 using global catalog locations and focal mechanisms indicates that the deformation from these events should be observable onshore using InSAR.

V51J-0401 0830h POSTER

Repeated Seafloor Geodetic Observation west off Miyake-jima volcanic island

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An intensive earthquake swarm started under Miyake-jima island, 180 km south off Japan main island, on June 26, 2000. The earthquake swarm migrated towards northwest off Miyake-jima island, where numerous earthquakes, more than 100,000, were detected within about two months and an extensive crustal deformation was observed by on-land geodetic observations. Inst. of Industrial Science, Univ. of Tokyo and Hydrographic and Oceanographic Dept, Japan Coast Guard deployed three seafloor geodetic reference stations (St.A, St.B & St.C) in triangle area surrounded by three islands, Miyake-jima, Nii-jima and Kouzu-jima islands, in November and December, 2000, and have been conducting observations using these three stations to monitor seafloor deformation for the better understandings of underground magmatic activities. The observations have been conducted thirteen times until present. Fast and quickly varying ocean current in this area prevented us from stable observation. The surface current makes the pole, which connects the GPS antenna and the ship-board transducer, bend. This bending of the pole gave uncertainty to the analyses of locating the positions of the seafloor geodetic reference stations. The pole was replaced new, more rigid pole to overcome the problem in August 2002. The first observation with this new system was conducted at the reference station in the Sagami-bay. Smaller amount of bending with the new pole than that with the old one against both roll and pitch components could be seen in the data from this observation. This shows that the replacement of the pole provided stability to the observation system. We started to adopt the new system to the observation at the three stations west-off Miyake-jima island area, too. Station C, that is located nearest one to the Miyake-jima island, is one where we had most frequent observation after improvement of the system. The observations with the new system have been conducted four times in September, December 2002, April and August 2003 there. We have been processing and analyzing the data from these four observations at Station C. More stable analyses have been done with the data from the observations which the new system was employed than with ones observed by the old system. In this poster, we will present the repeatability of the observation system with the new pole, as well as discuss the preliminary results from them.

V51J-0402 0830h POSTER

Thickness distribution of a cooling pyroclastic flow deposit: Optimization using InSAR, FEMs, and an adaptive mesh algorithm

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We construct finite element models (FEMs) of a pyroclastic flow deposit (PFD) emplaced during the 1986 eruption of Augustine volcano, Alaska. Interferometric synthetic aperture radar (InSAR) imagery documents the consistent contraction of the PFD during 1992-2000. Three-dimensional problem domains of the FEMs include an elastic substrate overlain by a thermoelastic material representing the PFD. The geometry of the substrate is determined from a digital elevation model (DEM) and bathymetry data. The thickness of the PFD is initially determined from the difference between post- and pre-eruptive DEMs. Systematic prediction errors suggest the PFD thickness distribution, estimated from the DEM difference, is inaccurate. We combine InSAR images, FEMs, and an adaptive mesh algorithm to re-estimate the geometry of the PFD and optimize the thickness distribution for the PFD. Prediction errors from the FEM that includes an optimized PFD geometry are reduced by 20% with respect to those from an FEM that includes a PFD geometry derived from the DEM difference.

V51J-0403 0830h POSTER

Magma Supply Dynamics of Okmok Volcano Inferred From Interferometric SAR

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Okmok volcano, located in the central Aleutian arc, is a shield volcano topped with a 10-km-wide caldera. The caldera-forming eruptions occurred about 8000 and 2400 years ago. Historic eruptions occurred in 1931, 1936, 1938, 1943, 1945, 1958, 1960, 1981, 1983, 1986, 1988, and most recently during February-April 1997. More than 70 Interferometric SAR (InSAR) images were used to study the transient deformation of the volcano before, during, and after the 1997 eruption. Coeruptive deflation of 1.4 m was detected. Point-source models suggest a magma reservoir resides at a depth of 3 km beneath the center of the caldera, which is about 5 km northeast of the eruptive vent. Pre-eruptive inflation from 1992 to 1996 was observed. The inflation rate decreased from about 10 cm/year during 1992-1993 to a nearly negligible magnitude during 1995-1996. The post-eruption inflation rate during 1997 and 2002 generally decreased with time, although the rate during 2000-2001 was exceptionally low. The location of the magma source during the pre-, co-, and post-eruption inflation periods is essentially constant. Interferograms spanning 1997-2002 captured at least two distinct deformation processes: (1) volcano-wide inflation due to influx of magma into the reservoir and (2) subsidence