V51F-0353 0830h POSTER

Comparing the Hazards From Large Volcanic Eruptions and Impacting Asteroids

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Explosive volcanic eruptions and asteroid impacts leave craters that allow direct comparison of the scale and frequency of these severe events. We have compiled data on large volcanic eruptions over the past 45 million years, and used this to develop an improved quantitative assessment of the frequency of large volcanic eruptions, and to make a comparative assessment of the relative likelihood of the Earth being affected by severe volcanic eruptions, and impact events of equal severity. In terms of volcanic activity, the expected frequency of explosive eruptions involving $> 10^{15}$ kg of rock lies between 1.3 and 22 events per million years. For the events that form terrestrial craters with diameters of order 10 - 25 km, the thermal energy release (during a volcanic eruption) is of the same order of magnitude as the kinetic energy release (from an asteroid impact), and ca. 10^{21} - 10^{22} J (2×10^5 - 2×10^6 Mt equivalent of TNT). Over the past 5 Ma, volcanic activity dominates the production rate of craters < 45 km diameter. This suggests that over short timescales (< 1 Ma), destructive volcanic eruptions are more frequent than impact events of a similar energy. A better comparison of the primary effects of both phenomena may be realised by considering the area destroyed by shock waves (impactors) or hot pyroclastic deposits (volcanoes). Using simple scalings, we show that the primary area destroyed by an impactor is about ten times that for an eruption. Using this area as a measure of severity, we can show that for events with a return period of 100,000 years or less, there are considerably more eruptions of a given severity than there are impact events. Impactor events only dominate for return periods of $>$ 200,000 - 500,000 years. We conclude that smaller ($< 10^{12}$ kg, < 1 km diameter) near-earth orbiters pose a significantly smaller hazard to humans than the regional effects of large (10^{14} - 10^{15} kg) volcanic eruptions.

V51G MCC: Level 1 Friday 0830h

Geologic History of Volcanic Regions I Posters

Presiding: **W J Williams,** University of Arkansas at Little Rock**; L Prueher,** U.S. Geological Survey

V51G-0354 0830h POSTER

Tertiary Volcanic Stratigraphy and Structure of the Sonora Pass Region, Central Sierra Nevada, California

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Mapping north and west of Sonora Pass provides information about the paleogeography and structure of the Sierra Nevada-Basin Range transition in Oligocene to Miocene time. The stratigraphy includes: (1) Late Oligocene-Early Miocene (?) Valley Springs Formation, composed of at least 5-6 petrographically distinctive silicic ignimbrites, overlain with erosional unconformity by (2) Early to Middle Miocene (?) "Relief Peak Formation", here referred to as Mehrten Formation, composed of hornblende andesite volcanic debris flow deposits, overlain with erosional uncomformity by channelized fluvial deposits, in turn overlain with erosional unconformity by block and ash flow tuffs, overlain with erosional unconformity by (3) the Middle or Late Miocene (?) Stanislaus Formation, composed of (a) latite lava flows ("Table Mountain Latite") and interbedded volcanic debris flow and fluvial deposits, overlain with erosional unconformity by (b) the Eureka Valley Tuff (EVT), also of latitic composition, in turn overlain with erosional unconformity by (c) latite flows, volcaniclastic fluvial deposits, or a debris avalanche deposit. The entire section is cut by andesite plugs. The basal ignimbrites are distal facies with source calderas in Nevada. The Merhten Formation is dominated by primary volcanic deposits in the east. The "Table Mountain Latite" is coarsely porphyritic plagioclase- and augite-phyric lava flows and flow breccias; it is only 83 m thick, with two flow units, in the west, and thickens to 344 m, with 21 flow units, in the east, suggesting a source not far to the east of the crest. The EVT consists of two members, each of which grade upward from densely welded to nonwelded latite ignimbrite. Distinctive lapilli- to block-sized clasts in both members are a distinctive mixture of highly flattened and plastically-deformed obsidian and rigid, vesicular bombs cored by obsidian. The tuff was probably erupted from a caldera only 22 km to the east. The Miocene strata generally thicken from west to east (over a map distance of 25 km) but locally thicken dramatically into paleocanyons cut in Mesozoic granitic rocks. A paleocanyon along the present-day Sierran crest trends NNW-SSE from Stanislaus Peak to Sonora Peak; it is sited along NNW-SSE, steeply-dipping faults in the Merhten Formation and filled by undeformed Stanislaus Formation latite flows. Similar relations occur along what is probably the same fault 5 km to the SSE at Sardine Falls. To the west of the crest, a pair of paleocanyons trending ENE-WSW occur at the Dardenelles in the north and the Red Peak-Bald Peak area in the south. This pair of paleocanyons is cut by a series of steeply-dipping NNW-SSE trending faults that include (from west to east): 1) a down-to-the-west fault between the Dardenelles and Dardenelles Cone, along which the Merhten Formation is highly deformed in a 250 m wide shear zone, and thickens from about 60 m to 200 m to the west across the fault, while overlying latite flows are only downdropped 60 m to the west, 2) the Bald Peak fault, also down to the west, where Merhten Formation thickens from 50 to 100 m to the west across the fault, and the base of the Table Mountain Latite is dropped 45 m to the west, and 3) the Red Peak fault, which drops the EVT down to the west approximately 200 m. Miocene strata of the Sonora Pass region record the onset of faulting both during and after deposition of the Merhten Formation, with continued faulting after eruption of the latite flows and tuffs. We speculate that the latites erupted during a phase of rapid extension in an arc otherwise dominated by andesitic volcanism.

V51G-0355 0830h POSTER

Stratigraphy and Structure of Late Oligocene-Early Miocene Ignimbrite-filled Paleovalleys, Northern Sierra Nevada, California

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Mapping of a Late Oligocene-Early Miocene (31-25 Ma) paleovalley system filled with ignimbrites erupted from calderas in present-day Nevada provides relationships necessary to deduce paleotopographic vs. structural controls on the paleogeography of the Sierra Nevada and its transition into the Basin and Range in Early Tertiary time. A paleovalley filled with five distinctive ignimbrites is well-exposed in the Diamond Mountains about 2 -3 km west of the Honey Lake fault zone, a segment of the northern Walker Lane fault zone. We map a N-S trending paleovalley approximately 7.2 km wide, using ignimbrite distributions and thicknesses of ignimbrites and sedimentary rocks, as well as compaction foliation, cooling joints, welding zonation and lateral variations within each ignimbrite. Paleotopographic relief in the metamorphic and granitic basement reaches approximately 223 m; metamorphic roof pendants form steep-sided paleoridges and spires, while the granitic basement forms stepped relief controlled by pre-existing joints. The five ignimbrites are composed of at least nine mappable cooling units that vary laterally, from ca. 260 m thick paleovalley axis deposits to ca. 70 m thick paleovalley wall deposits, with dramatic thickening of vitrophyres toward paleovalley walls. The lowest three ignimbrites are confined to the paleovalley, the fourth passes upward from confined to unconfined, and the fifth is entirely unconfined. All of the ignimbrites are cut by two N-S trending, steeply W-dipping faults; the first, near the axis of the paleovalley, shows maximum 85 m of dip-slip displacement, and the second, near the eastern margin of the paleovalley, shows ca. 40 m of dip slip displacement. These N-S faults parallel the paleovalley and are oblique to the modern (NW-trending) Honey Lake fault zone, suggesting they may be older. Evidence for syndepositional faulting is present along the paleovalley axis fault, where sedimentary rocks between ignimbrites 3 and 4 thicken from several meters to 60 m onto the downthrown block, and along the fault near the eastern paleovalley margin, where ignimbrite 4 thickens from 50 to 90 m onto the downthrown block. We correlate ignimbrite units 3, 4 and 5 of the Diamond Mountains with ignimbrites filling paleovalley erosional remnants near Frenchman Lake (26 km to the SSE), Haskell Peak (52 km to the SSW), and Soda Springs (91 km to the S). At Soda Springs (located 8 km SW of Donner Pass) the N-S trending paleovalley is about 6 km wide. The western paleovalley wall is composed of metamorphic basement rock and is steep, with paleotopographic relief of at least 280 m, whereas the eastern side of the paleovalley is predominantly granitic and is characterized by less dramatic relief. The paleovalley contains seven ignimbrites composed of at least ten cooling units. We correlate units 1, 4 and 7 of the Soda Springs paleovalley with units 3, 4, and 5 of the Diamond Mountains paleovalley, on the basis of petrographic and outcrop characteristics. The ignimbrite sequence is 323 m thick, and has mappable erosional unconformities with relief of up to 30 m between units 4, 5 and 6. The upper three units locally spread beyond the paleovalley walls. We have not recognized any faults in this paleovalley. Late Oligocene-Early Miocene ignimbrite-filled paleovalleys in the Diamond Mountains, Frenchman Lake, Haskell Peak and Soda Springs may represent remnants of a once-continuous valley 117 km long that trended obliquely to, and presumably crossed, the modern range front faults prior to their development.

V51G-0356 0830h POSTER

Tertiary Paleogeography and Paleotectonic Evolution of the Sierra Nevada in the Carson Pass-Kirkwood Area, California

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Volcanic and sedimentary rocks of the Miocene Mehrten Formation in the Carson Pass- Kirkwood Valley-Silver Lake area of Sierra Nevada (California) occupy a paleocanyon cut into Mesozoic granitic rocks. Nine unconformities were recognized within the sequence during recent fieldwork, demonstrating that the canyon was repeatedly incised. The lowest 5 units are dominantly braided stream and minor debris flow deposits with silicic to intermediate-composition volcanic clasts. These clasts, together with interstratified ignimbrites, were probably derived from volcanic centers to the east in Nevada, prior to the Sierra Nevada range front faulting. The upper 4 units are dominated by andesitic volcanic debris flow and debris avalanche deposits, interstratified with andesitic to dacitic lava domes, flow breccias, block-and-ash-flow tuffs and peperite intrusions. These units record the westward sweep of the arc from Nevada into the present-day Sierran crest, and development of high-relief centers that probably blocked sediment supply from the east. No significant faults were recognized in the region, although a N-S trending paleocanyon wall on the north side of Carson Pass was mistaken as a fault by previous workers. Ar/Ar dating in progress on volcanic rocks of units 2, 4, 6 and 8 will constrain the timing of the eight canyon incision events. The origin of the incision events is not yet clear.

V51G-0357 0830h POSTER

Peperite-Fed Andesitic Debris Flows in the Miocene Mehrten Formation, Kirkwood, California, USA

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The Miocene Mehrten Formation is a voluminous predominantly andesitic suite of volcanic rocks erupted along the crest of the Sierra Nevada mountains in northern California. At Kirkwood, California, the Mehrten Formation comprises a sequence of primary volcanic andesitic debris flow deposits, debris avalanche deposits, block-and-ash flow deposits and distal fine-grained rhyolitic ignimbrites, overlying a predominantly reworked sequence of andesitic fluvial debris flow, hyperconcentrated flood and streamflow deposits. The Mehrten Formation in this area is intruded by several andesitic dikes which are both contemporaneous with and postdate the debris-flow deposits. The volcanic debris flow deposits display an unusual internal structure comprising discrete domains of either brittle or ductile-fragmented juvenile blocks in an ash to lapilli-sized matrix. The matrix is locally parallel laminated but where present is often partially

destroyed along contacts with juvenile clasts. Some domains of ductile-fragmented clasts are clearly fed from dike-like intrusions, while others display no evidence of feeder bodies. The latter are typically more intimately mingled with the brittle domains. Ductile domains are generally smaller in cross-section (<1-50m across) than the brittle domains (<1-300m across). The feeder dikes display both fluidal and brittle fragmentation at their margins. These observations suggest that the ductile domains and at least some (or all?) of the blocky domains represent peperite, formed when wet andesitic pyroclastic ash and lapilli deposits on or immediately below the paleosurface was intruded by andesitic magma. Individual juvenile clasts in the peperite range from several millimeters up to half a meter in size. The absence of feeders to many of the peperite domains suggests that the domains were truncated from their feeders and subsequently entrained during downslope flow. This observation also suggests the possibility that intrusion and consequent peperite generation could have initiated and sustained this primary debris flow eruption mechanism. Such a mechanism for the initiation of potentially hazardous debris flows has been largely ignored, though it is not yet clear how applicable this mechanism is to other volcanic debris flow deposits, in the Mehrten Formation or elsewhere.

V51G-0358 0830h POSTER

Correlation and Analysis of Volcanic Ash in Marine Sediments From the Peru Margin: Explosive Volcanic Cycles of the North-Central Andes

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To decipher the episodicity of explosive volcanic activity in the North-Central Andes, we have measured the thickness and calculated the volume of ash layers from sites drilled along the Peru margin during Leg 201 of the Ocean Drilling Program (ODP). The geographic distribution of the sites (over 3 degrees of latitude and from 50 to 300 km offshore) and correlation of ash units between sites form the basis for minimal estimates of explosive volcanic activity in the region (only eruptions large enough to deposit ash in excess of 100 km from source are represented). Pouclet et al., (1990), estimated the minimum explosive activity along the Andean Arc from ash-bearing sediments and ash layers within cores from sites along the Peru margin collected during ODP Leg 112. As a result of higher recovery (as much as ten times more core recovery in many intervals) and decreased disturbance in cores recovered during Leg 201, our documentation of ash content in cores from Leg 201 has led to a more complete record of the explosive volcanic activity along the Andean Arc. For example, Pouclet, et al., (1990), reports four ash layers from Sites 680 and 684, whereas we have documented fourteen ash layers from cores recovered from the same locations (Sites 1228 and 1227, respectively). Our stratigraphic record agrees with Pouclet, et al., (1990), suggesting that explosive activity began in the early Eocene (∼35Ma) and continued with explosive pulses during the Miocene. The greatest explosive activity occurred within the past 5 million years, with peak activity in the late Pliocene to early Pleistocene. Based on petrographic and geochemical analysis, most of the volcanic ash within cores from Leg 201 was derived from the Andean volcanic arc. These plinian eruptions produced acidic glasses and ash layers with abundant feldspar, hornblende, and biotite. Pouclet, et al., (1990), reports a transition from andesitic volcanism in the Middle to Late Miocene to a more shoshonitic composition through the late Pliocene to early Pleistocene during peak volcanic activity. However, ash layers from at least one drilling location (Site 1228) bracketed by biostratigraphic and oxygen isotope dates may correlate with the 254 kyr eruption of Taupo. Previous studies have recognized the presence of tephra from this eruption in cores as far away as 1100 km from the source, and suggest that ash may be found in sediments off South America (Froggatt, et al., 1986). REFERENCES Froggatt, P.C., Nelson, C.S., Carter, L., Griggs, G., Black, K.P., 1986. An exceptionally large late Quaternary eruption from New Zealand. Nature (London), 319; 6054: 578-582. Pouclet, A., Cambray, H., Cadet, J.P., Bourgois, J., De Wever, P., 1990. Volcanic ash from Leg 112 off Peru. Proceedings of the Ocean Drilling Program, Scientific Results, Vol. 112: 465-480.

V51G-0359 0830h POSTER

Paleotectonic Significance of the Upper Cretaceous Frontier Bentonites, Wyoming.

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The major problems concerning the Upper Cretaceous Frontier bentonites in north-central Wyoming are (1) their source areas, (2) paleotectonic setting, and (3) their original ash composition. Detailed trace-element geochemistry, detrital mineralogy, and field relationships associated with the bentonite beds were used to assess the composition and to characterize the provenance of the volcanism. Geochemical plots using Ti-Zr-Y and Nb-Zr-Y contents indicate a lower group (Peay bentonite) of thin tephra of dominantly alkali basaltic composition and an upper group (Torchlight bentonites) of thick and variable tephras of andesitic to basaltic andesite composition. Geochemical signatures within the bentonites indicate that the volcanism in the northerly source region changed composition with time. The progression from homogeneous but generally silica-undersaturated (Peay bentonites) to consistently silica-saturated magmas (Torchlight bentonites) with time suggests an increase in the degree of partial melting and a decrease of crustal involvement with time. Furthermore, the overall composition and immobile trace element geochemistry of the bentonites indicate that the source volcanoes had a similar plate-continental affinity and were spatially related.

V51G-0360 0830h POSTER

THE CENTRAL ATLANTIC MAGMATIC PROVINCE: AGE COMPARISON BETWEEN THE SOUTH CAROLINA DYKES AND MOROCCO LAVA FLOWS

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Believed to be the largest volcanic province on Earth at more than 6000 km long and 2000 km wide, the Central Atlantic Magmatic Province (CAMP) stretches from Eastern Canada to Brazil and from Western Spain to the Ivory Coast. Due to the massive erosion and subsequent in filling of these areas since the 200 Ma rifting event, dikes and sills constitute the majority of the exposed CAMP volcanics. However, well preserved lava flows have been found in the Triassic basins of the Northeastern United States and Morocco. Despite numerous $^{40}Ar/^{39}Ar$ dating attempts, very few of the exposed CAMP volcanics have been successfully dated due to a variety of factors including; excess argon and alteration. Especially no age is available in the well-mapped but structurally complex South and North Carolina dykes swarm as well as only few scattered ages in the Moroccan Trias-Liassic basins. Our goal is to better constrain the emplacement timing of the dykes swarm but also to compare age of both intrusive and effusive rocks from the same magmatic event but separated from more than 1000 km, 200 Mys ago. Several questions continue to surround the CAMP volcanic province including its cause and emplacement mechanism. Toward that end we have collected and dated dyke samples from the Carolinas and flows in Morocco, 1000 km away and across the rift. We anticipate that a comparison of these dates will enable us to understand more about the timing between the emplacement of the flows and dykes. We have collected in South Carolina and High Atlas in Morocco 7 and 9 hand samples respectively. Specimens from South Carolina correspond to the three distinct dykes' direction NE-SW, NW-SE and NS. In Morocco, samples were collected in four sections (100 to 300 m thick) located in the High Atlas between Marrakech and Ouarzazate. From each hand sample two different transparent plagioclase fractions, 250-180 and 180 to 100 microns, were separated. We have performed step heating experiments at the Berkeley Geochronology Center using a defocus CO_2 laser. Plateau ages obtained in both areas are undistinguishable at 2 sigma level ranging from 201 to 198 Ma (relative to FCs at 28.02 Ma). This is coherent with previous ages in Brazil and NE-US and reinforced the instantaneous emplacement at the geological time scale of this enormous volcanic province with ramifications for tectonic and climatic processes.

V51G-0361 0830h POSTER

The Valle de Bravo Volcanic Field. A monogenetic field in the central front of the Mexican Volcanic Belt

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The Valle de Bravo volcanic field, VBVF, is located in the central-southern front of the Mexican Volcanic Belt just to the southwest of Nevado de Toluca volcano. The VBVF covers 3,703 square Km and includes at least 122 cinder cones, 1 shield volcano, several domes, and the 2 volcanic complexes of Zitacuaro and Villa de Allende. Morphometric parameters calibrated with isotopic ages of the volcanic products indicate four groups or units for the VBVF, Pliocene domes and lava flows, undifferentiated Pleistocene lava flows,> 40 Ka cones and lavas, 40 to 25 Ka cones and lavas, 25 to 10 Ka cones and lavas, and < 10 Ka cones and lavas. Whole-rock chemistry shows that all products of the VBVF range from basaltic andesites to dacites. No basalts were found, in spite of many units are olivine-rich and large some with large weight percent contents of MgO, 1 to 9. There is the possibility that some or all of the olivines in some samples could be xenocrysts. Some andesites are high in Sr, 1000 to 1800 ppm, that correlates with relatively high values of Ba, Cr, Ni, Cu, CaO and MgO. Y and Nb have the typical low values for orogenic rocks. The only shield volcano of the VBVF has a base of 9 Km, and its composition is practically the average composition of the whole field. Stratigraphycally, it is one of the earlier events of the VBVF. Compared with other volcanic fields of the Mexican Volcanic Belt, it lacks basalts and alkalic rocks. All volcanism of this field is calcalkaline

V51G-0362 0830h POSTER

Remote Sensing and *In Situ* Information: Looking at the Potrillo Volcanic Field of the Southern Rio Grande Rift in a more Spatially Integrated Way

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Studies of the Potrillo volcanic field in the southern Rio Grande rift have resulted in robust datasets for volcanic stratigraphy, geochemistry and both ^{3}He surface exposure and $^{40}Ar/^{39}Ar$ geochronology to produce a magma dynamics model. Williams' model incorporates the physical, spatial, temporal, chemical, and emplacement mechanisms for this Pleistocene age field. Volcanic activity was not continuous throughout its 1 Ma - 20 ka history. Rather, there has been punctuated activity with frequent shifts of foci and some reoccupation of edifices after 50 ka upwards to 100 ka of quiescence. At least five eruptive phases have been documented and field-wide polycyclicity on the order of 10^3 to 10^5 years now quantified. Our current study uses remote sensing techniques that include Enhanced Thematic Mapper Plus (ETM+) and Advanced Space-borne Thermal Emission Reflectance Radiometer (ASTER) integration along with Digital Elevation Map (DEM) analyses. Evaluation of the remote sensing imagery with *in situ* information allows for correlation of geologic field relationships to spectral response, evaluation of deposit age versus deposit degradation (e.g. hematite development and/or spectral response), and better recognition

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of temporal-spatial volcanic center distributions in relationship to structural control. We also demonstrate an effective method for using ASTER data for geological mapping and other field studies in arid regions. ASTER has 14 bands, hence allowing for 364 red-green-blue (RGB) color combinations. Therefore, we apply a statistical approach including the Optimum Index Factor (OIF) to assist in selecting the most effective RGB color combinations for discriminating different geological materials. Small volume basaltic centers such as found in the Potrillo volcanic field do display a broad range of morphologic features, with several similar to those interpreted from the Mars Orbital Lander Altimeter (MOLA) topographic data: shields and flows (lava-tube and fissure-fed). A better understanding of Mars planetary volcanism through terrestrial analogs can be gained by integrating remote sensing, temporal, geochemical and geologic spatial information. Therefore, presented are preliminary observations of the Potrillo deposits for use as a terrestrial analog, with emphasis on phreatomagmatic centers (e.g. Kilbourne Hole and Malpais maar) in order to draw comparisons with martian landforms influenced by water (ice) during eruptions.

V51G-0363 0830h POSTER

The Volcanic Periodicity in Central and Southern Luzon, the Philippines: as Inferred from Tephra Study in the Ocean Core

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The completeness and continuous nature of marine sediment sequences makes marine tephrochronology an excellent geologic record of past volcanism from the general area. Total of 21 tephra layers in the giant piston core MD972142 raised from northern Palawan, South China Sea by the IMAGES 1997 cruise were identified for this purpose. The age constrains of tephra layers were based on the proxy of the previous reported foraminifer oxygen isotope stratigraphy. The tephrochronological results show two major periods of the tephra deposits in this area, 870 ka to 810 ka and 480 ka to present, respectively. It was notable that the volcanic activities between the above two periods existed an obvious about 330,000 yrs of apparent quiescence in this area. The fingerprints of mineral assemblages, chemical and isotopic compositions of glasses in tephra help to trace back to the potential on land sources. Seventeen layers of total 21 layers in the MD972142 in the younger deposit period dominantly consisted of the brown to light-brown sponge-type or pumice-type glass particles with some plagioclase, clinopyroxene and rare biotite. The SiO2 contents and 87Sr/86Sr values of glasses in these tephra layers revealed the range from 56 to 72 wt % and 0.7045 to 0.7053, respectively, those are indistinguishable with the previously reported characteristics of the volcanic rock from the Macolod Corridor segment (0.7043-0.7053). The rests of 4 tephra layers, three in the older deposit period and one at 83 ka, mostly constituted by white pumice, biotite and plagioclase. Characteristics of the calc-alkaline series of glasses, ranges from 73 to 79 wt % in SiO2 and 0.7039 to 0.7044 values in 87Sr/86Sr ratio, are well correlated to the reports from the Bataan Segment (0.7041-0.7045) in the central Luzon. The above results clearly illustrated that the volcanic activities in the Bataan segment with the more differentiation in the chemical compositions and less eruptive frequency was interrupted at around 800 ka, and after about 330,000 yrs of apparent quiescence, the volcanic activities in the Macolod Corridor segment dramatically increased the intensities and frequency from last 480 ka. It can be interpreted as corresponding with the changing stress field on the Philippine Fault in this area. In previous study, the tectonic setting of the Macolod Corridor segment has been considered as a pull-apart rifting zone or a shearing zone, mainly originated by the Philippine Fault. The volcanic activities in this region have been interpreted as related to the rifting environments. From above studies, in summery, overall fluctuations in the volcanic periodicity in central and southern Luzon should be correlated the variations in the regional tectonic (stress) regime field with time.

V51G-0364 0830h POSTER

Geology and stratigraphy of the Tacaná Volcanic Complex, Mexico-Guatemala

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The Tacaná Volcanic Complex (TVC) lies at the intersection of three important fault systems. The oldest is located west of the complex and consists of fractures and NE-SW faults affecting only granitic rocks of Paleozoic and Tertiary. The second fault system is aligned NE-SW, parallel to the TVC, while the youngest fault system is aligned N-S and crosscuts the other two fault systems. The TVC rises over a local basement of Paleozoic metamorphic rocks, early Miocene granodiorites and tonalities, and a late Tertiary volcanic sequence composed of welded green ignimbrites, and indurated block-and-ash flows (up to 100m thick). This latter volcanic sequence is likely associated with the nearby Tertiary-Quaternary caldera structures Pavincul and San Rafael. The TVC itself consists of four structures aligned in a NE-SW direction: Chichuj, Tacaná, San Antonio volcanoes , and Las Ardillas dome. At least three avalanche deposits have been found around the complex all of them covered by block-and-ash flow deposits of 38,000, 28,000 and 16,000 yr. B.P. The San Antonio volcano produced a Peléan-type eruption dated at 1,950 yr. B.P. that may represent the youngest eruption of the complex. However, the 1950, and 1986 phreatic explosions at Tacaná volcano attests to the potential hazard to the surrounding population of 250,000 people.

V51G-0365 0830h POSTER

Origin, Age, and Geochemistry of the Tuff of Saguache Creek, Southwestern Colorado

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A crystal-poor, rhyolitic, ash-flow tuff in the Eastern San Juan Volcanic Field currently known as the tuff of Saguache Creek (TSC) was reinterpreted by Simon and Wendlandt (1999) as not being distal Sapinero Mesa Tuff. Currently there is no source caldera established for this tuff thereby leaving uncertainties in the volcanic history. Regional mapping of the TSC has subsequently been completed to constrain a possible source caldera. Petrographic studies, and EPMA and LA-ICPMS analyses of the mineral assemblage have been performed to characterize further the tuff, enable correlation of mapped TSC, and constrain petrogenetic models. Petrographic and chemical identification of the TSC builds on characteristics set forth by Simon (2000). These characteristics include abundant feldspar clusters, alkali feldspar mantled plagioclase, no modal quartz, Fe-Ti oxides (often with apatites and zircons), and sparse biotite and pyroxene. Pyroxenes show curiously high MnO (avg 2.70 wt%) and Mg# (avg 79.2) and might be xenocrystic. In comparison, biotites have much lower MnO (avg 0.82 wt%). Average sanidine (Or50) and plagioclase (Ab71) compositions fall within the documented range (Simon, 2000) and show little trace element substitution including Eu <3 ppm and Ba <1200 ppm. Titanites are enriched in Ce (17,000-20,000 ppm) and Pr (2,200-2700 ppm). Apatites show similar enrichment in Ce (2200-7600 ppm) and Pr (330-350 ppm). Confirmed outcrops of TSC are best preserved just north of Trickle Mtn where it is approximately 30 m thick and overlain by a welded airfall ash deposit preliminarily dated at 29-30 Ma. Outcrop localities south of Colorado Highway 114 show thinning and are interpreted as erosional remnants plastered on older Conejos age volcanic deposits. Similarly, an andesitic topographic high just west of Trickle Mtn has TSC vitrophyre on the east-facing slope suggesting strong north-south channeling of the flow unit by paleo-topographic lows. Outcrop elevations also decrease from north to south supporting a possible source caldera to the north. This source could be explained by a distinct circular gravity low on the southeastern slope of the Continental Divide. The low is bordered to the north by a circular arrangement of peaks as well as debris breccias, andesitic flow breccias, and lahars.

V51G-0366 0830h POSTER

40Ar/39Ar Geochronology of Hypabyssal Igneous Rocks in the Western Amazon Basin of Peru: a Record of Thermal History, Structure, and Alteration

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Hypabyssal dacites located in the western Amazon basin of Peru record the thermal, tectonic, and alteration history of the area. The dacites were emplaced into the foreland of the Andean fold and thrust belt, and are the only known intrusions along the deformation front in Peru. Deformation in the fold and thrust belt occurred approximately 16 Ma. Preliminary 40Ar/39Ar geochronology on three hornblende separates yields crystallization ages of 12 Ma, younger than the folding and faulting. The dacites are located within a domed area, which includes Cretaceous shales and sandstones of the Chonta and Vivian formations and Tertiary shales, sandstones and tuff of the Pozo, Yahuarango and Chambria formations. Petrographic evidence shows that the dacites are not deformed, but locally underwent quartz-sericite-pyrite alteration during later hydrothermal activity. Argon geochronology on hornblende and potassium feldspar will define cooling history and age of the intrusions. Argon geochronology on sericite will provide a minimum age of the hydrothermal alteration. Seismic data are being examined to determine if the rocks form a stock-like feature or a laccolith similar to that observed in the Henry Mountains, Utah, which represent analogous igneous rocks in a similar setting.

V51H MCC: Level 1 Friday 0830h

Geothermal and Low-Temperature Fluid-Rock Reactions Posters

Presiding: **I Chou,** U.S. Geological Survey

V51H-0367 0830h POSTER

Understanding the Chemical and Structural Dynamics of a Geothermal System Using Hyperspectral Imaging and Field Observations, Dixie Meadows, Nevada

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Dixie Valley hosts the largest geothermal plant in the state of Nevada. As part of an exploration program to evaluate other geothermal sites we mapped a 16 km swath of the eastern front of the Stillwater Range, including the Dixie Valley Fault system (Caskey et al. 1996) and Dixie Hot Springs. This visibly hydrothermally altered portion of the range front is located 25 km south of the existing plant and 10 km north of a major bend in the Dixie Valley Fault System. We used hyperspectral (HyMAP) data to locate outcrops of high temperature, hydrothermally altered minerals (including alunite, kaolinite, dickite, jarosite, and hematite). Several outcrops of these altered minerals exist in the mapped region, and one area of roughly 1