

spans the episodes of gold precipitation. Pre-ore quartz and calcite occur as fragments in fault breccias. Ore related minerals are generally euhedral and are divided into 3 stages: Early - barren quartz; Intermediate - quartz, zoned fluorite, realgar, pyrite, marcasite, and gold; Late - clear calcite, realgar, stibnite, pyrite, marcasite, and minor gold. Intermediate quartz, fluorite, and realgar contain abundant primary and secondary inclusions that were studied using microthermometry and quadrupole mass spectrometry (QMS).

Pre-ore minerals trapped fluids with salinities of 6-36 wt % NaCl equiv. at $T > 200^\circ\text{C}$. Intermediate quartz and fluorite contain two-phase H_2O -dominant inclusions. In addition, fluorite contains three-phase H_2O - CO_2 inclusions. Primary, two-phase inclusions have salinities of ~ 4 wt % and homogenize at $150^\circ\text{--}160^\circ\text{C}$. Secondary, three-phase inclusions have salinities < 1 wt % and yield minimum P-T estimates of ~ 400 bars and 265°C .

QMS analysis of inclusion gases (in mole %) provides evidence of 3 populations of inclusions in intermediate-stage minerals. Individual inclusions in quartz and fluorite were opened by thermal decrepitation over T 's from $100^\circ\text{--}500^\circ\text{C}$. Inclusions in realgar were released by crushing at 25°C . Quartz and fluorite contain H_2O - CO_2 inclusions that range from H_2O -dominant (H_2O -85%) to CO_2 -dominant (CO_2 -60%) with variable $\text{CO}_2/(\text{CH}_4 + \text{C}_2\text{H}_6)$ ratios of 1 to 100, and significant H_2S (0.1 to 1%). Fluorite also contains gas-dominant, hydrocarbon (HC) inclusions with CO , CO_2 , H_2 , H_2S and SO_2 . Inclusions in realgar are H_2O -dominant with less CO_2 ($\sim 2.5\%$), CH_4 ($\sim 0.3\%$), and H_2S ($\leq 0.008\%$).

Pre-ore fluids are probably related to Cretaceous igneous activity. HC inclusions are thought to represent gas liberated by pyrolysis of solid kerogen during QMS analysis. The H_2S -bearing, H_2O - CO_2 inclusions are likely ore fluids capable of decalcification, gold transport, and gold precipitation by cooling, mixing, and sulfidation of host rock iron. The compositional range of H_2O - CO_2 inclusions may be evidence of immiscibility/pressure fluctuations in the Geitchell fault zone. Gas-poor fluids in realgar may reflect influx of dilute meteoric water. Marcasite is indicative of T 's $< 240^\circ\text{C}$ and pH < 5 during gold deposition.

No 4385

LATE CENOZOIC VOLCANISM IN THE LASSEN AREA, SOUTHERNMOST CASCADE RANGE, CALIFORNIA

Clynnne, Michael A., MUFFLER, L.J. Patrick, and DALRYMPLE, G. Brent, U.S. Geological Survey, 345 Middlefield Road MS910, Menlo Park, CA 94025. Volcanism in the southernmost Cascade Range can be characterized on two scales. Regional volcanism is predominantly basaltic to andesitic, and hundreds of coalescing volcanoes of small volume (10^3 to 10^4 km³) with short lifetimes have built a broad platform. Superimposed on the regional volcanism are a few long-lived ($\sim 10^6$ years) much larger ($> 10^2$ km³) volcanic centers. Each of these larger centers consists of a basaltic-andesite to andesite composite cone and flanking silicic domes and flows. The evolution of these volcanic centers conforms to a generalized three-stage model during which a conspicuous edifice is constructed. Stages I and II comprise a dominantly andesitic composite cone; Stage III marks a change to dominantly silicic volcanism and is accompanied by development of a hydrothermal system in the permeable core of the andesitic composite cone. Subsequent fluvial and glacial erosion produces a caldera-like depression with a topographically high resistant rim of Stage II lavas surrounding the deeply eroded, hydrothermally altered core of the composite cone.

Four volcanic centers have been recognized south and southeast from Lassen Peak in the area covered by the Lake Almanor 1:100,000 map. The Yana volcanic center was situated in the drainage of Butt Creek in southeastern portion of the map area and was active in the Late Pliocene. The Maidu volcanic center dominates the central portion of the map area and was active from about 2.4 to about 0.8 Ma. The Dismar volcanic center was located in the northeastern corner of the map area and was active from about 1.8 to about 0.7 Ma. Activity at the Lassen volcanic center, the southernmost active volcanic center in the Cascade Range, began at about 0.65 Ma.

Two types of basalt are recognized in the southernmost Cascades: medium-K calc-alkaline (CAB) and low-K olivine tholeiite (LKOT). CAB exhibits considerable geochemical diversity and is the parent magma for the volcanic-center lavas and the majority of the evolved regional lavas. LKOT is chemically homogeneous, and outcrops sporadically in association with extensional tectonics of the Basin and Range Province, and is related to Pleistocene encroachment of Basin-and-Range tectonics on the subduction-related volcanism of the Cascade Range.

No 4776

ROLE, STATUS, AND ACTIVITIES OF WOMEN-FACTORS CRITICAL TO ENVIRONMENTAL QUALITY IN THIRD WORLD DEVELOPMENT

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Human activities have long been known to contribute to environmental degradation in Third World Countries. Less well understood has been the intense women/environment interaction. Women traditionally have been perceived as primarily acting within the environment, but new understanding recognizes women as a powerful force shaping the environment. Third World women interact directly with the natural environment more than do men. Women grow most of the food; they manage water and sanitation practices; they gather fuelwood, which deforests large areas and creates ever greater labor demands to gather the same quantity of fuel. These activities, which often are not part of the money economy with which economists work, are not generally considered in economic models and development planning; economic development projects often are considered successful, even where they produce environmental degradation, precisely because accepted accounting procedures take no account of environmental damage.

An approach to sustainable development that does not degrade the environment must: a) genuinely incorporate the concept that interventions in the environment send effects throughout the ecosystem, of which humans are a part, and b) take into account that women and environment vitally affect each other. Because women's roles, attitudes, and traditions make them the main environmental managers, women also can be a major force in reclaiming

environment. Experience shows that the minority of Third World development projects built on these approaches yield higher rates of sustainable results, and less environmental disruption.

We in the natural sciences must demonstrate to the development community that our expertise is needed to control environmental degradation and generate a better real return on the development dollar. In addition, because of the intimate women/environment interaction, many problems of environmental degradation and depletion cannot be addressed without an understanding of the role of women in the ecosystem.

No 21888

PHOTOGRAMMETRIC ANALYSIS OF QUATERNARY HILLSLOPE EROSION AT YUCCA MOUNTAIN, NEVADA

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Relict colluvial boulder deposits provide a source for assessing long-term hillslope erosion rates at Yucca Mountain. Low-altitude stereo aerial photographs provide a base for accurate measurements of the amount of colluvium removed by erosion from these middle-Pleistocene deposits (dated by varnish cation ratios).

In this study, two 1:3000-scale stereo photographs of hillslope deposits on the west side of Yucca Mountain were oriented in an analytical stereo plotter using surveyed ground control points. Then, a Digital Elevation Model (DEM) with 2 m spatial resolution covering the entire hillslope was measured from the oriented stereo pair. Next, the hillslope deposits were divided into upper, middle, and lower groups based on different slope gradients. A best-fit mathematical plane was calculated on the surface of each group using 3D points measured from the stereo photographs, the generic plane equation ($ax + by + cz + d = 0$), and a least squares adjustment. These planes model the original surface of the deposits before any hillslope erosion took place. Elevations on these planes were subtracted from corresponding hillslope DEM node elevations to calculate the elevation change caused by cumulative erosion since the middle Pleistocene. The total volume of material removed by erosion for each deposit group was calculated by multiplying the elevation change at each node by the cell area (4 m^2), and summing all of the resulting cell volumes. The volume lost for the upper, middle, and lower groups was divided by the total area covered by each group to yield the volumetric change per unit area ($0.2 \text{ m}^3/\text{m}^2$, $0.8 \text{ m}^3/\text{m}^2$, and $0.3 \text{ m}^3/\text{m}^2$, respectively). Dividing these values by cation ratios for each group (465 ka for upper, 645 ka for middle and lower) results in vertical ground lowering rate estimates of 0.5 mm/ka , 1.2 mm/ka , and 0.5 mm/ka , respectively. Conditions that promote these low erosion rates include: (1) the weathering resistant nature of varnish-coated fine-grained volcanic boulders in a dry, semi-arid climate, (2) boulder deposits that inhibit slope-wash erosion by permitting surface-water infiltration, (3) the infrequent and generally localized nature of rainfall capable of causing debris flows, and (4) isolation of middle and lower hillslope deposits from active erosion by topographic inversion.

No 6384

THE CASE FOR PRE-MIDDLE CRETACEOUS EXTENSIONAL FAULTING IN NORTHERN YUCCA FLAT, SOUTHWESTERN NEVADA

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Extremely complex low-angle fault relationships within the Late Proterozoic to Pennsylvanian sedimentary rocks near Yucca Flat, Nevada Test Site, have been previously ascribed to Mesozoic compression during the Sevier orogeny, or to middle Tertiary extension of a pre-existing thrust stack. New field evidence and detailed studies of a 3500-foot drillhole show that this structural complexity results from post-thrust regional extension that may be much older than previously recognized. The interpreted age constraint is inferred from thermal disequilibrium recorded by rocks above the altered monzonite(?) porphyry border phase of an intrusion ($^{40}\text{Ar}/^{39}\text{Ar}$ emplacement age = 102 ± 3 Ma from biotite) penetrated in the bottom of the drillhole. The pluton intrudes middle Devonian dolomite that forms the lowermost of at least seven structural sheets. Each sheet is bounded by breccia zones and consists of an identifiable slice of the local Paleozoic section (middle Ordovician, upper Silurian, or Devonian dolomite, or Mississippian siltstone), without ordered sequence. Conodonts from the dolomites show color-alteration indices (CAI's) greater than 4.5 at the top of the drillhole and as high as 7 near the bottom. Hydrothermal alteration is indicated by non-uniform CAI values within discrete (50-foot) sample intervals and by etched conodont surfaces. The intervening structural sheets of carbonaceous siltstone also appear to have been thermally disturbed because they yield essentially no volatile hydrocarbons during pyrolysis. All observed features are consistent with thermal overprinting by the 102 Ma intrusion and permit an interpretation that the complicated fault/stratigraphy relationships also predate 102 Ma. Outcrop studies of numerous low-angle faults within the Paleozoic and late Proterozoic rocks in this region indicate that many are extensional, whether they involve younger-over-older or older-over-younger relations. We infer a dominantly extensional origin for the structural sheets encountered in the drillhole on the basis of similarities with the outcrop faults (breccia style, scarcity of schistosity in the siltstones, and fault-bedding relations), but the sheets must have been derived from the upper plate of the nearby CP thrust fault.

No 6180

QUATERNARY FAULTS OF WEST TEXAS

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North- and northwest-striking intermontane basins and associated normal faults in West Texas and adjacent Chihuahua, Mexico, formed in response to Basin and Range tectonism that began