NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

MAY MEETING / STUDENT POSTER EXHIBIT

DATE: **Wednesday, May 30, 2001**

LOCATION: **Orinda Masonic Center, 9 Altarinda Rd., Orinda**

TIME: **6:30 p.m. Social; 7:00 p.m. talk (no dinner)**
Cost is $5.00 per person

RESERVATIONS: Leave your name and phone number at 925-294-7530 or by e-mail at dday@nrmc.com **before the meeting.**

SPEAKER: Dr. David Mustart, Department of Geosciences, San Francisco State University

Hydrothermal Pipes in Three Granitic Plutons of the Tuolumne Intrusive Suite, Sierra Nevada Batholith, California

The genesis and migration of a magmatic volatile phase in association with granitic plutons continues to be the source of much speculation. Our work suggests that a significant avenue for transmission of such fluids in silicic epizonal intrusions is by streaming of an aqueous fluid through cylindrical hydrothermal pipes. Following our initial report of hydrothermal pipes in three widely separated areas of the Sierra Nevada and Transverse Range of California, we have concentrated our recent investigations on the Tuolumne Intrusive Suite in Yosemite National Park. The hydrothermal pipes are typically circular to ovoid in cross-section, range in diameter from a few centimeters to over four meters, and most often occur in localized groups. We have documented the occurrence of more than 400 hydrothermal pipes hosted within the three most silicic units of the Tuolumne Intrusive Suite: the Half Dome Granodiorite (366 pipes), the Cathedral Peak Granodiorite (44 pipes) and the Johnson Granite Porphyry (6 pipes). The majority of pipes (62%) occur either directly centered on, or within one meter of a pegmatite or pegmatite-aplite dike. Most pipes display concentric zoning with an outer rind enriched in quartz, potassium feldspar and muscovite, and a core composed primarily of internally nucleated albite and epidote, with intercrystalline spaces partially filled with fine-grained chlorite displaying a radial to spherulitic habit.

Evidence that a fluid phase has streamed through the pipes is suggested by presence in the pipe core of a finely milled microbreccia of epidote, quartz and plagioclase enclosed in a matrix of spherulitic chlorite. The zonal mineralogy frequently leads to differential weathering of the pipes producing a recessed core and a protruding rind. The resultant similarity of surface expression to potholes, weathering pans and miarolytic cavities, may explain why hydrothermal pipes have apparently been overlooked by previous workers in the Sierra Nevada. The abundance of hydrothermal

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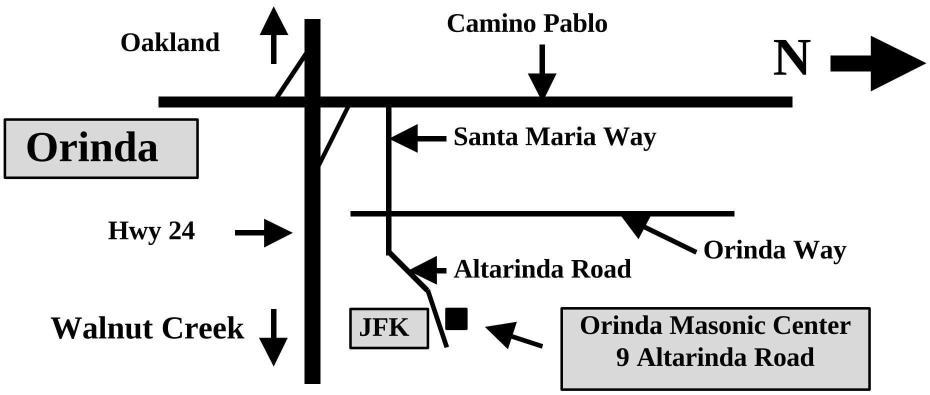

pipes in the Tuolumne Intrusive Suite suggests to us that such conduits are a common feature of similar epizonal silicic plutons, and have originated in large part by upward migration of a magmatic volatile phase released from the associated pegmatites.

Dr. David Mustart is Professor of Geology at San Francisco State University. He received his B.S. degree in Trace Element Geochemistry from the University of British Columbia (1965) and his Ph.D. in Geology from Stanford University in 1972. He immediately joined the faculty of San Francisco State University, where he was Assistant Professor (1972-1979), Associate Professor (1979-1986), and full Professor of Geology (1986-present). He was Department of Geosciences Chair from 1978 to 1981. Dr. Mustart's research inrterests include experimental petrology, geochemistry, economic geology, and soils geology. His most recent research work has focused on hydrothermal pipes in granitic plutons of the Sierra Nevada Tuolumne intrusive suite as evidence of magmatic volatile phase migration.

Please note: A poster exhibit by NCGS Scholarship recipient *Lin Murphy* of Cal State University, Hayward, entitled *"Silica-rich Volcanic Rocks of the Berkeley Hills"* will be displayed from 6:15 to 7:00 p.m. at the May 30th meeting (details inside).

Northern California Geological Society
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Would you like to receive the NCGS newsletter by e-mail? If you are not already doing so, and would like to, please contact **Dan Day** at ***dday@nrmc.com*** to sign up for this service.

NCGS 2001-2002 Calendar

Wednesday, May 30, 2001
Dave Mustart, San Francisco State University
Tentative title: **Hydrothermal Pipes in Six Granitic Plutons in California: Evidence for Evolution and Migration of a Magmatic Volatile Phase**
Orinda Masonic Center

Wednesday, June 27, 2001
Bruce Jaffe, USGS Menlo Park
Tentative Title: **Mercury Contaminated Hydraulic Mining Debris in North San Francisco Bay: A Legacy of the Gold Rush**
Orinda Masonic Center

Wednesday, September 26, 2001
Richard Sedlock, San Jose State University
Tentative title: **Blueschists and Ophiolites in Baja: Coast Range Geology, But With Outcrops**
Orinda Masonic Center

Wednesday, October 24, 2001
David Lawler, Far West Geoscience Foundation, Berkeley (Tentative)
Title: **Hydraulic Gold Mining's Historical Legacy - Mercury Contamination Issues: Sierra Nevada and Klamath Mountain Regions, California**
Orinda Masonic Center

Wednesday November 28, 2001
David Des Marais, NASA Ames Reseach, Menlo Park
Title: **The Biogeochemical Carbon Cycle and the Coevolution of Early Earth and Biosphere**
Orinda Masonic Center

Wednesday January 30, 2002
Roger Ashley, USGS Menlo Park
Title: **Lode Gold Deposits of the Sierra Nevada and Their Environmental Impacts**
Orinda Masonic Center

Student Poster Exhibit at May 30th NCGS Meeting

California State University Hayward graduate student **Lin Murphy**, a 2000 recipient of the NCGS annual college scholarship award, will have a poster exhibit displaying the results of her research on silica-rich volcanic rocks in the Berkeley Hills. ***The exhibit will be held from 6:15 to 7:00 p.m. before the meeting. Members are invited to come early to view the exhibit and talk to Lin about the important research she has conducted on these unusual igneous rock exposures.*** A brief abstract of Lin's poster topic, **Silica-rich Volcanic Rocks of the Berkeley Hills**, follows:

Scattered throughout the Berkeley Hills are silica-rich rocks, which have been mapped as Tertiary, but which are now considered to be Upper Jurassic. The geologic map of the San Francisco-San Jose Quadrangle (1991) identified these rocks as "rhyolite of Uncertain age" and grouped them as part of the Coast Range Ophiolite. Graymer and others (1996) characterized them as volcanic rocks (keratophyre and quartz keratophyre) overlying the Coast Range Ophiolite. Though now mapped as one unit, the widespread Leona and the areally restricted Northbrae may be distinguished from each other by their petrology, their geochemistry, and their morphology.

Petrology indicates that the Northbrae formed as a glass flow or dome: it contains flowbanding, autobrecciated clasts, relict spherulites, and a microcrystalline matrix. The Leona exhibits no flowbanding or autobrecciation. It contains glomerocrysts of plagioclase in a matrix of plagioclase laths. Northbrae exhibits resilicification textures and the Leona does not. In outcrop, Northbrae surfaces are frequently rounded, with some extremely polished areas. Leona outcrops, in contrast, are jagged, rough, and fractured. The geochemistry of the Leona Rhyolite shows a flat REE (rare earth element) signature, similar to the keratophyres of the Coast Range Ophiolite (Blake and Jones, 1981). By contrast the Northbrae samples all show light REE enrichment and a negative (supressed) Eu (europium) anomaly. Northbrae plots as an anomalous ridge, whereas Leona plots as a volcanic arc (Pearce, 1984).

This research suggests that the Leona and the Northbrae Rhyolites do not have the same petrogenesis and that they are distinct rock units. Our data suggest that the Northbrae may be an exotic block within the Franciscan Complex or the Coast Range Ophiolite. To see photographs, thin sections, and geochemical plots from Lin's research work, please visit the web site http://eqdoc.home.netcom.com**.**

April NCGS Meeting Topic Discusses Desert Soil Genesis in Alluvial Fan Deposits

The NCGS enjoyed a return speaking engagement from Past-President **John A. Karachewski**, Weiss Associates, Lawrence Livermore National Laboratory (LLNL), at the April 25th meeting. John's presentation ***"Geology of Southern New Mexico and the Desert Soil-Geomorphology Project"*** was based on John's experiences at an international conference / field trip honoring **Dr. Leland H. Gile**, project co-founder and pioneer of soil research. The Desert Soil-Geomorphology Project was hosted by the Soil Conservation Service, the New Mexico State University Department of Agronomy, and the New Mexico Bureau of Mines and Mineral Resources. John acknowledges the contributions of LLNL scientists Fred Hoffman and Kim Heywood; Weiss Associates colleagues Richard Weiss, Mike Dresen, Zafer Demir, and Melissa Chamberlain; and Michigan State University researcher Gary Weissmann.

While working on subsurface alluvial deposits and paleosols at LLNL, John attended the May, 2000, conference to examine the excellent paleosols near Las Cruces, New Mexico. The field area lies in a 400 square mile study area striding the Rio Grande rift. The rift valley extends from southern Colorado through New Mexico and into northern Mexico. The rift intersects an Oligocene caldera and volcanics. Basin formation and major block faulting occurred in the Miocene, and glacially-driven incision of the Rio Grande accompanied by axial fluvial system development and renewed faulting in the Plio-Pleistocene. These events have been chronicled by sequence stratigraphy, paleomagnetic signature (magnetostratigraphy), tephrochronology (radioactive dating of volcanic ejecta), and vertebrate paleontology. Key tephrostartigraphic events (time lines) are the Yellowstone Lava Creek Ash eruption at 660,000 years ago, the Mammoth Lakes Bishop Tuff explosive event at ~770,000 years B.P. (before present), and the Jemez Caldera pumice conglomerate deposited 1.6 million years ago. These events are supplemented by vertebrate fossil control.

The Project field trip focused on two key basins in the rift valley; the Palomas Basin half-graben and the Hatch-Rincon Basin full-graben. The sedimentary architecture of the basin alluvial deposits are cyclic sedimentary packets that include debris flows, fluvial channels, conglomerates, and turbulent flow regimes that developed paleosols (ancient soil horizons) during periods of suppressed sedimentary deposition. The shedding of sediments into the basins is controlled by tectonics and climate, the latter tied to Quaternary glacial cycles. The alluvial fan "cyclothem" in a semiarid/arid to subhumid/semiarid paleoclimate cycle involves repeated upward sequences of 1) calcic soil development and channel incision; 2) turbulent-flow conglomerate deposition; and 3) hyperconcentrated-flow pebbly sandstones. The entire cycle packet averages about 5 meters thick. The fluvial/alluvial fan architecture includes multiple axial-fluvial channel deposits cross-cutting turbulent-flow conglomerates. These Plio-Pleistocene fluvial-lacustrine glacial-driven sediments are cemented with groundwater-deposited authigenic carbonate. In general, these weathered geomorphic surfaces show increasing carbonate content with age. The oldest paleosols in this region are about 900,000 years old. This mountainous region also shows vertical climate variations from arid below 5,000 feet to to semiarid at elevations above 5,000 feet. The authigenic carbonate in the Palomas half-graben occurs in both hanging wall and footwall paleosols, nodules and tubules, groundwater carbonate deposits with capillary fringe, and phreatic carbonate spar cement. Currently the groundwater depth lies 20 to 30 feet below the surface southwest of Las Cruces to about 300 feet northwest of town.

The paleosol-forming process in the Las Cruces area depends on the parent material, the age of the soil horizon, the topography, the climate, the vegetation, and human influences. Leland Gile was interested in soil calcification. Gile and his colleagues trenched numerous alluvial fans to study their internal structure and how it related to soil calcification and paleosol genesis. Over the last 45 years Giles carefully catalogued the geomorphic surfaces he studied, utilizing aerial photography to characterize soil development on terraced arroyo outcrops. Prior to human settlement of the area, several geomorphic surfaces had formed. The caliche zones could be dated using carbon 14 and uranium series radioactive isotope techniques. The earliest surfaces defined by these techniques included the Holocene Fillmore and Organ surfaces (1,000 to 4,000 years old) and the Latest Pleistocene Leasburg and Isaacks' Ranch surfaces (8,000 to 15,000 years old). Slightly older are the 15,000 to 75,000 year old Picacho and Jordana Iisurfaces (Late Pleistocene). The Jordana I surface of Late Middle Pleistocene time is 250,000 to 400,000 years old. And the Middle Pleistocene to Early Pleistocene Lower and Upper La Mesa surfaces are the oldest in the region at 400,000 to 500,000 years old. The spatial relationship of these geomorphic surfaces to one another was carefully determined by Gile and his coworkers. Much of the finer structure and complexity of these massive fan deposits was revealed in the trench studies. The fan sedimentary architecture has a strong bearing on contaminant migration through the subsurface, particularly where breeches in the paleosol carbonate "seal" occur. John showed slides of a large bajada (several coalescing alluvial fans) complex emanating from the highly dissected, jagged granitic Organ Mountains east of Las Cruces. The various geomorphic surfaces are often evident in aerial photographs and show increasing erosional dissection with age. Up to four prehistoric cut-and-fill geomorphic events could be identified in the last 6,000 years by radiocarbon dating of archeological fire pit charcoal. Gile and others ultimately chronicled over a million years of soil development underlain by the 1.6 million year old Jemez Pumice event.

Climate conditions play a major role in alluvial fan formation and paleosol development. New Mexico has a monsoonal climate with 75% of the annual precipitation falling during the summer months. At this time, extensive playas are formed. Conditions are arid (less than 10 inches of annual precipitation) below 5,000 feet, and are reflected in thin organic-rich A soil horizons. Above 5,000 feet the climate is semiarid (10 to 16 inches annual precipitation) with thicker A horizons and increased vegetation cover. Superimposed on this recent climate cycle are the Quaternary glacial cycles that fluctuate between today's hot-dry interglacial (stadial) conditions and pluvial periods of cool-dry to cool-moist conditions. The soil master horizons that developed in the study area begin with a dark, organic-rich surface A horizon; beneath is an oxidized, altered, and bio-mixed clay-bearing horizon; next is a pedogenic carbonate-rich K horizon; it is underlain by a relatively unaltered C horizon that preserves original sedimentary structures; and the sequence culminates in essentially unaltered bedrock (R horizon). Historical settlements established between 1885 and 1920 significantly changed the local vegetation due to grazing and adverse land use practices. Grasses were replaced by mesquite and the unprotected soil was heaped by the wind into sand dunes.

John attended the Southern New Mexico Desert Soil-Geomorphology Project to observe paleosol formation in alluvial fan complexes and apply what he learned to work he is doing for Weiss Associates at Lawrence Livermore National Laboratory. LLNL lies atop ~4500 feet of Franciscan and Great Valley Sequence gravel and alluvium shed off the northern Diablo Range and the Altamont Hills to the east during Plio-Pleistocene times. Soil-forming processes in the Livermore Valley differ from those in New Mexico based on parental material (New Mexico fans contain Tertiary volcanics and granitic rock types), age, tectonics, topography, climate, vegetation, and soil horizon development. The Livermore deposits have poor age control, are subject to more rapid subsidence rates, are bounded by strike-slip and thrust faults rather than normal faults, are smaller alluvial-fluvial systems in a region of lower relief, experience a Mediterranean-style climate (wet winter-dry summer) versus New Mexico's summer monsoonal weather pattern, have an oak-grassland vegetation, and lack good surface exposures of soil horizons. In general, the Livermore Valley paleosols are more subtle, lack the extensive carbonate-rich horizons seen in New Mexico, and have less gravel and more silt/clay debris flow strata. LLNL does benefit from excellent core datasets, abundant core geophysical data, and the detailed hydrostratigraphic studies conducted by other on site research groups. Manganese oxide and calcium carbonate-bearing stacked paleosols are common in the Livermore Valley sediments. John's work on LLNL cores has also benefitted from the expert analysis of Michigan State University researcher Gary Weissmann, who examined samples for links between subsurface geology and hydrostratigraphic behavior. Detailed work also has been performed on core samples to link the lithology and geophysical properties with interpreted sedimentary environments. These collaborative efforts are being applied to a nine well grid placed on 25 foot spacings near the Lab's NIF (National Ignition Facility) site to monitor the results of electro-osmosis tests being conducted to drive adsorbed contaminant-bearing water out of clays. The stratigraphic interpretation allows scientists to plan well screening programs and remediation strategies at the test site, and helps guide data interpretation. The evolution and identification of paleosols at LLNL is a key part of continuing research to understand contaminant transport in complex alluvial fan systems.

The NCGS thanks John Karachewski of Weiss Associates for his superb discussion of paleosol development in a rift valley alluvial fan environment. His presentation also featured spectacular photographs of desert landscapes to give the audience a glimpse of the serene beauty of Southern New Mexico's Rio Grande Valley. Those interested in seeing more of John's highly acclaimed photography can check his web site at **http://www.geoscapesphotography.com.**