The Salt River Project (SRP), the principal water purveyor of the Phoenix area and the second largest power utility in Arizona operates an extensive network of canals, laterals, wells, several power plants and a power distribution system. These structures are very sensitive to ground leveling and consequently to ground surface adjustments produced by land subsidence. SRP has instituted a pilot program to monitor these effects, determine the extent of the impacts on its more potentially influenced structures and has investigated the use of remedial measures, such as subsidence control using ground water recharge wells.

A research project undertaken by SRP to evaluate the use of low sun angle aerial photography for detection of subsidence associated earth fissures in the Salt River Valley demonstrated its applicability. This method is based on the examination of low altitude air photos of the terrain taken during early morning or late afternoon. This enhances shadows at ground surface and permits the identification of linear patterns. Field screening of these features determines if they are the expression of subsidence fissures. This technique is very cost effective and is employed to monitor large areas.

Subsidence effects on specific structures, such as canals and wells are monitored using Global Positioning System (GPS) surveys, a recently developed satellite radio telemetry method. Progressive ground sinking and tilting can be evaluated using this technique at a reasonable cost compared to conventional first and second order topographic surveys. A test for the applicability of the GPS has been completed in the large Arizona Canal.

10:15 a.m. Cronin, Vincent S. № 28675

ENGINEERING GEOLOGY MUST BE DOMINATED BY A PUBLIC-SAFETY-BASED ETHIC

CRONIN, Vincent S., Geosciences Dept., University of Wisconsin–Milwaukee, P.O. Box 413, Milwaukee, WI 53201

The most serious problem affecting the profession of engineering geology is not scientific or technical; it is the prevalence of unethical practice (*e.g.*, failure to collect, consider or report all relevant data; failure to consider all relevant hypotheses to explain the data; failure to make conservative interpretations based upon the primary data in order to protect public safety; advocacy for potentially hazardous projects proposed by an employer.) Unlike lawyers, who must defend their client using every legal means available regardless of the client's state of guilt, geologists do not have an obligation to defend or promote the untenable plans of their employer. The principal client of all engineering geologists is the public. The main purpose of engineering geology is to identify and usefully characterize geological conditions that may be hazardous to the public. Engineering geologists who fail to provide competent and ethical service endanger not only the public, but also the profession and their employers.

The case study of a proposed high-density condominium development atop a small mesa in Malibu, California, provides an example of poor practice and its consequences. The authors of the site evaluation omitted, misrepresented or misinterpreted critical data concerning seismic risk, slope stability, and the health hazards from seeps of septic effluent that would have been an inevitable result of the planned development. Local property owners lacked faith in the normal review procedure used by governmental agencies that administer the building code, so they retained independent engineering geologists to review the proposal. (It is significant that private citizens had to hire their own experts in order to induce the system to work.) Permits for the proposed development were denied when the critical flaws of the original site investigation were identified in the public forum. Curiously, the response of the engineering geologists whose report was rejected was to accuse the reviewers of unethical behavior, on the antiquated theory that one qualified professional has no right to question the work product of another professional. This ethical theory is not viable in science because of the skeptical, questioning nature of scientific inquiry. If all engineering geologists achieved a high standard of care based upon the ethic of protecting public safety, there would be no need to fear critical peer review of a professional work product.

10:30 a.m. Crisman, Robert G. № 32461

GEOLOGIC BIAS AND ITS AFFECT ON GEOTECHNICAL SITE EVALUATIONS: OLD VAIL RANCH, TEMECULA, CALIFORNIA.

CRISMAN, Robert G., MCCLAY, Paul L., GeoSoils, Inc., 5741 Palmer Way, Carlsbad, CA 92008; SHLEMON, Roy J., P.O. Box 3066, Newport Beach, CA 92659-0620

The western boundary of the Old Vail Ranch (OVR) project occurs along a sinuous geomorphic escarpment separating a Holocene flood plain within Wolf Valley from dissected uplands underlain by the Plio-Pleistocene Pauba Formation. The Wildomar Fault, geomorphically well-expressed immediately to the north of Temecula Creek, has traditionally been extended to this escarpment.

A previous fault hazard investigation designated the geomorphic escarpment as the active trace of the Wildomar Fault, primarily based on the apparent juxtaposition of the Pauba Formation and the Holocene valley fill in trenches. Consequently, an active fault zone and a structural setback of 50 feet had been established and approved by the reviewing agency.

Later, however, we sited new trenches immediately adjacent to the previous excavations. No faults were encountered; rather, the Pauba Formation and alluvium were juxtaposed along a west dipping erosional contact. Accordingly, the active fault and setback restrictions were removed.

It thus appears that the original fault assessment was "geologically biased" relying solely on previous reconnaissance and on regional geomorphic trends rather than on site-specific trench information. A possible southern extension of the Wildomar Fault in the OVR area is yet unknown. It may terminate north of the OVR or be located further southwest within Wolf Valley.

10:45 a.m. Florsheim, Joan L. № 25607

GEOMORPHIC ANALYSIS FOR RESTORATION OF A TIDAL MARSH: SLOUGH CHANNEL EVOLUTION AND MARSH PLAIN SEDIMENTATION, SAN FRANCISCO BAY, CA.

FLORSHEIM, Joan L., GOODWIN, Peter, WILLIAMS, Philip B., ABBE, Tim, and BOOKER, Fred A., all at Philip Williams & Associates, Pier 35 The Embarcadero, San Francisco, CA 94133.

Worldwide destruction of salt marsh habitat has accelerated in the past century due to rapid urbanization of coastal regions. In San Francisco Bay, California, over 95% of wetlands have been lost to urban, agricultural, and industrial uses. An inter-disciplinary effort to restore a portion of the original salt marsh habitat at the Sonoma Baylands (diked in the 1800's for agricultural uses), located in San Francisco Bay is in progress. Subsidence at the site has lowered the ground surface elevation by 1.5 to 2.5 m below the elevation of Mean Higher High Water. Our work includes: 1) analysis of marsh plain and slough channel evolution; and 2) modeling of the sedimentation rate.

Field investigations and geomorphic analysis of slough channel development were conducted for several sites around San Francisco Bay on natural and restored marshes in order to develop geomorphic guidelines for restoration at Sonoma Baylands. Marsh plain elevation on natural marshes with well developed slough channel systems is slightly higher than the elevation of MHHW. Restored marshes which used dredge materials to increase the marsh plain elevation more rapidly than would occur by the natural sedimentation rate do not exhibit slough channel development when the dredge material is placed higher than approximately 0.5 m below MHHW suggesting that the evolution of the slough channel system is integrated with sedimentation on the marsh plain. A method to model the increase in marsh plain elevation over time (Krone, 1983) was used to predict the rate of marsh plain accretion for the restored tidal marsh at Sonoma Baylands. Two alternatives were investigated: 1) time required for sedimentation to raise the marsh plain from the present elevation to the elevation of MHHW; and 2) the time required to raise the marsh plain from 0.5 m below MHHW to MHHW by using dredge materials to raise the initial elevation. When sediment concentration is low, the time scale for development of the marsh plain and associated slough channel system is slower than when the concentration is high. This analysis shows that in North San Francisco Bay (which has high natural sediment concentrations), increasing the marsh plain elevation using dredged materials can reduce the time necessary to develop a marsh plain by approximately 10 to 20 years.

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11:00 a.m. Jibson, Randall W. № 16614

LANDSLIDES TRIGGERED BY THE 29 APRIL 1991 RACHA EARTHQUAKE IN SOVIET GEORGIA

JIBSON, Randall W., U.S. Geological Survey, Box 25046, MS 966, Denver Federal Center, Denver, CO 80225; PRENTICE, Carol S., U.S. Geological Survey, 345 Middlefield Rd., MS 977, Menlo Park, CA 94025.

On 29 April 1991, an earthquake (M=7.2) struck the Racha region of the Caucasus Mountains in northern Soviet Georgia. The earthquake occurred on a shallow-dipping thrust fault striking roughly east-west; focal depth was less than 20 km. Much of the structural damage and at least half of the approximately 100 fatalities were caused by landslides triggered by strong shaking. We documented landslides in an area measuring about 80 km by 30 km; the total area affected by landslides probably is somewhat larger. Five types of landslides were prevalent (in decreasing order of abundance): rock falls, debris slides, earth slides, slumps, and rock-block slides. Only one mud/debris flow was reported, but it destroyed the village of Khaheti and killed about 50 people.

The types of landslides triggered by the earthquake related closely to local lithology and geologic structure. Rock falls were abundant from vertical escarpments in Mesozoic limestone and from steep road and stream cuts in Jurassic volcanic rocks. Debris slides were common on very steep slopes composed of colluvium and residuum derived from Jurassic volcanic rocks and from alluvial stream terraces. Earth slides occurred in weak, complexly deformed, deeply weathered Miocene claystone. Slumps formed primarily in deeply weathered volcanic rocks. Rock-block slides occurred primarily on dip slopes in Mesozoic sedimentary rocks.

The largest landslides triggered by the earthquake were earth slides. Numerous active earth slides in the Miocene claystone existed before the earthquake; many of these moved several meters during the spring rains in the weeks preceding the earthquake but moved only a few centimeters to a few decimeters during the earthquake. Two large earth slides, about 20-30 million m^3 each, moved a very small amount during the earthquake, but 3 days later moved 20-30 m and 50-70 m, respectively. One of these slides destroyed the village of Chordi.

Although this earthquake triggered abundant landslides, the area we documented as being affected by landsliding is an order of magnitude smaller than maximum areas affected in earthquakes of this magnitude from worldwide data compiled in 1984 by D.K. Keefer. Also, earthquake-triggered movement on preexisting active landslides, compared to the rainfall-induced movement that occurred only weeks before the earthquake, seems very small. These observations indicate that the shaking intensity and (or) duration from the Racha earthquake may not have been as great as that commonly produced in other earthquakes of this magnitude.

11:15 a.m. Neal, James T. № 32131

SITE EVALUATION OF SALT DOMES FOR POTENTIAL EXPANSION OF THE U.S. STRATEGIC PETROLEUM RESERVE (SPR)

NEAL, James T., Sandia National Laboratories, Albuquerque, NM 87285-5800; MAGORIAN, Thomas R., 133 South Drive, Amherst, NY 14226; SMITH, Richard E., U.S. Department of Energy, Washington, D.C. 20585; WHITTINGTON, Don W., U.S. Department of Energy, New Orleans, LA 70123

The Department of Energy (DOE) has undertaken further studies of candidate petroleum storage sites for expansion of the SPR to one billion barrels, pursuant to the 1990 Congressional amendments to the Energy Policy and Conservation Act. Eight candidate salt dome sites, which appear to meet preliminary criteria for storage capacity, distribution logistics, security, geotechnical suitability and environmental acceptability were identified. The eight sites include Chacahoula, Cote Blanche, Napoleonville, and Weeks Island in Louisiana; and Big Hill, Boling, Hawkinsville, and Stratton Ridge in Texas. The sites have been described in a March 1991 DOE report to Congress and DOE has begun environmental impact analyses of all candidates.