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CONFERENCE REPORT

Pacific Section Convention (1999) of the American Association of Petroleum Geologists

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This annual meeting in April 1999, was sponsored by the oldest regional section of the American Association of Petroleum Geologists and hosted by the Monterey Bay Geological Society. The meeting itself was held in Monterey, California, the former capital of Spanish, and later, of Mexican California.

One might question the relevance to Canadian interests of this regional meeting of a non-Canadian geological society. However, Canada markets natural gas from western Canada to California through the Pacific Gas and Electric natural gas transmission pipeline. This gas is produced both in Alberta and British Columbia. My contribution to this meeting concerned the prolific Slave Point and Keg River gas fields of northeastern British Columbia, which, as I pointed out to my listeners, supply a portion of California's energy requirements.

A major theme for the entire convention was the geology of marine settings. Consequently, there were a number of talks from other international locales with marine settings, such as offshore areas of the Gulf Coast, the Caribbean, Japan, Pakistan, Russia, the United Kingdom, and Norway (North Sea). I believe, however, that I represented the sole Canadian contribution to this meeting of about 400 registrants.

In keeping with the stated theme of the meeting "Monterey's Hidden Resources," most talks dealt with some aspect of the Monterey Bay area and the magnificent 4000-metre deep submarine Monterey Canyon, one of the largest submarine canyons in the world. The Monterey Bay Aquarium Research Institute (MBARI) provided the spectacular sonar-based bathymetric imagery of the Monterey Canyon region that appeared in many talks. The largest technical sessions of the conference were the oral and poster sessions dealing with "Fluid Seeps on Active Continental Margins." Many presenters demonstrated that hydrocarbons and aqueous fluids are actively flowing from submarine seeps in the Monterey Bay area (*e.g.*, D. Orange (U.California, Santa Cruz), G. Greene (MBARI), T. Naehr (MBARI)) and in many other submarine settings, such as offshore Santa Barbara (P. Eichhubl (MBARI) and J. Clark (U.California, Santa Barbara), Cascadia Ridge, C. Goldfinger (Oregon State U.), the Sea of Okhotsk, Russia (E. Suess (GEOMAR Research Center, Kiel, Germany) and T. Lorenson (USGS, Menlo Park)), and the Gulf of Mexico (I. MacDonald (Texas A&M U.)).

Almost all examples of submarine fluid seeps discussed at this conference are "cold" seeps. In contrast to the more well-known black smokers that spew forth sulphide-laden hydrothermal fluids of up to 350° C on the sea floor, cold seeps involve fluids that are within a few degrees of the ambient seawater bottom temperatures. Also, unlike the black smokers that occur along active sea floor spreading ridges, the relatively recently discovered cold seeps occur along transform continental margins of that are convergent or transpressive, with strike-slip faulting as the dominant structural style.

Sea floor cold seeps are manifested by the outflow of sulphurous and methane-rich fluids that support large chemosynthetic benthic faunas of clams, mussels and worms around the seeps. In an intriguing occurrence, Suess described large barite chimneys, several metres high, above cold seeps in the Sea of Okhotsk. More commonly, cold seeps are manifested as carbonate chimneys up to a metre high and carbonate pavements both on the modern-day sea floor and in Tertiary strata along the California coast (Aiello *et al.*, 1999).

Naehr linked fluid venting of methane-rich fluids to compressional tectonics and to the decomposition of gas hydrates near the sea floor and Lorenson suggested that most of this methane has a microbial source. In contrast, L. Magoon (U.S. Geological Survey, Menlo Park) found that hydrocarbons in seeps along the California coast and inland are thermogenic in origin and have deeper Tertiary sources many kilometres away.

The second major conference theme concerned strike-slip faulting along the California coast, and in particular with the San Gregorio Fault (SGF), a seaward fault splay of the San Andreas Fault. Joe Clark (Indiana University, Penn.) and others led a spectacular field trip along the California coast from Point

Año Nuevo (Fig. 1) southward to Point Lobos and Garrapata Beach south of Monterey stopping at localities where the San Gregorio Fault outcrops and displays Holocene offsets (Fig. 1).

Speakers at the San Gregorio Fault session discussed different scenarios for rates and timings of movements along the SGF and other related faults based on a variety of indicators. Joe Clark led off the session with a summary of what is known or assumed about SGF displacements (initial Late Miocene slip rates of 25-30 $mm \cdot a^{-1}$ decreasing to 6 $mm \cdot a^{-1}$ in post-Pliocene time) based largely on cross-fault formational displacements. G. Weber (U. California, Santa Cruz) used offsets of marine terraces to estimate 8-9 $mm \cdot a^{-1}$ of dextral movement on the SGF as well as a small amount of dip slip movement. K. Burnham (Oakland, CA), on the basis of detailed petrography, geochemistry and radiometric dating, provided a convincing correlation between the conglomerates exposed at Point Reyes north of Monterey with those of Point Lobos south of Monterey and inferred that there was about 180 km of post-Eocene dextral offset along the SGF.

Several talks focussed on the transfer of these dextral movements south of the SGF. W. Lettis (W. Lettis and Associates, CA) suggested that the SGF passed southward to the San Simeon and Hosgri Fault systems in a 410 km long system within which displacement rates decay from >6 $mm \cdot a^{-1}$ in the SGF to <3 $mm \cdot a^{-1}$ in the San Simeon and Hosgri faults. Decay of displacement southward is attributed to transfer of slip into a left-restraining stepover bend joining the SGF with the San Simeon Fault. This stepover caused uplift of some of the coastal areas (Santa Lucia Range). In a similar vein, L. Rosenberg (consultant, Templeton, CA) suggested that part of the dextral slip along the SGF may be passed on to the Garrapata Fault, which strikes inland away from the San Simeon Fault and towards intra-Salinian (Cretaceous granite) fault segments of the northern Santa Lucia Range.

R. Sedlock (San José State U., San José, CA), in a sobering appraisal of inferred displacements across the SGF, took issue with most of the criteria for quantitative estimates. He pointed out that the SGF and its southward extensions lack true piercing points, the unique points that can be correlated with absolute certainty across faults, in contrast to merely similar rock facies and rocks with similar provenances and formational contacts. He suggested that, instead of a southward decay of fast slip, that the SGF itself had a slow <3$mm \cdot a^{-1}$ slip rate with no necessity to shed displacement south of the SGF.

It was a welcome interlude in this session to view the offshore seismic imagery of the SGF presented by S. Lewis (California State U., Fresno) showing the geometry of the SGF as the basinward limit of an imbricate landward-dipping fan of westward-verging faults beneath Monterey Bay and interpreted to be a thrust belt. Dip slip movements clearly caused doming of the sea floor. A strong component of dip-slip in addition to strike-slip movements along the SGF was also indicated by the detailed seismic results presented by K. McNally (U. California, Santa Cruz), which also indicated that the SGF dipped eastward at 50° to 70° and that deeper earthquakes were due to thrust fault-type mechanisms.

An interesting link between the two main themes of the convention, marine seeps and coastal fault systems, was provided by talks that pointed out that most marine seeps occur on the sea floor along these faults (J. Boles, U. of California, Santa Barbara), and C. Goldfinger). Joe Clark, our field trip leader, also mentioned that the secret weapon for mapping these faults on land was to map the occurrence of surface springs.

This was a memorable convention for me personally, and provided insight into styles of strike-slip faulting, a recent interest of mine. All in all, a great conference in a unique locale. Where else could a geological investigation of fault-directed spring sapping lead to the front door of Doris Day (Joe Clark, personal communication). The glossy *Volume and Guidebook, GB-76* produced for this convention is well worth the US$27.00 and is available from the Pacific Section of the AAPG.

REFERENCES

Aiello, I. W., Stakes, D.S., Kastner, M. and Garrison, R.E., 1999, Carbonate vent structures in the Upper Miocene Santa Cruz Mudstone at Santa Cruz, California, *in* Garrison, R.E., Aiello, I.W. and Moore, J.C., eds., Late Cenozoic Fluid Seeps and Tectonics along the San Gregorio Fault Zone in the Monterey Bay Region, California: Volume and Guidebook, GB-76, Pacific Section, American Association of Petroleum Geologists, p. 35-52.

Figure 1 The second stop of the San Gregorio Fault Zone field trip led by Joe Clark (Indiana University of Pennsylvania), Gerald Weber (University of California, Santa Cruz), Lewis Rosenberg (Consultant, Templeton, California) and Kathleen Burnham (Oakland, California). Here, strands of the San Gregorio Fault Zone cross Point Año Nuevo (inset) north of Monterey. Quaternary-aged movements (Año Nuevo Thrust) caused the Miocene Monterey Formation siltstones to have overridden submarine talus and debris deposits eroded from the Monterey itself.