Deep Terrestrial Heat-Flow Studies in Southwestern United States

Deep geothermal gradient measurements yielding good heat-flow data are necessary to accurately predict lithospheric and asthenospheric temperatures and relate thermal conditions in the lithosphere and asthenosphere to fundamental tectonic processes such as vertical movements in the earth. Many heat-flow measurements are calculated from temperature gradients taken at depths less than 1 km. In some places, groundwater perturbation of these temperature gradients precludes basic appreciation of regional lithospheric or local geothermal conditions. Previous heat-flow data suggest the Colorado Plateau is an area of low heat flow (~1.2 HFU) whereas new deeper heat-flow measurements show the Colorado Plateau has intermediate heat flow (~1.6 HFU). These new data are in keeping with other geophysical measurements. As such, the gradual uplift component of vertical movement over the western United States since the Eocene may relate to lithospheric reheating (thermal expansion) as North America drifted over hotter asthenosphere. New deep data in the southern Basin and Range province indicate regional heat flow of 1.95 HFU suggesting 0.3 to 0.4 HFU difference between the Basin and Range and Colorado Plateau. Different lithospheric responses to asthenospheric anomalies may allow widespread magma intrusion in the Basin and Range with only modest intrusion in the Colorado Plateau. Both large scale and local geothermal anomalies are also significantly perturbed by groundwater movement, e.g., the Rio Grande rift and the San Francisco Mountains. High quality heat-flow data extending along profiles from mountainous areas will allow appreciation of thermal conditions in mountain blocks and magma bodies, such as profiles from the southern Rockies and the San Juan Mountains.

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Conodont Animal—Hypotheses and Speculations

More than a century after their discovery, conodonts remain biologic orphans. These skeletal constituents of some as yet unspecified marine organisms have been assigned by various workers to: vertebrates (from ancestral to advanced), arthropods, several kinds of worms, several classes of mollusks, lophophorates, separate classes (or a phylum) all their own, and even algae and vascular plants. Functional interpretations of conodonts include: stem, gill, or tentacular supports; dermal spines and scales; radulae; digestive tract stirrers and sieves; jaws, teeth, or "superteeth;" and copulatory graspers. Each conodontophorid bore up to at least two dozen, commonly very differently shaped, conodont elements in an apparatus. The existence and makeup of these multi-element apparatuses are known from naturally occurring assemblages of elements that are interpreted as coprolitic, gut contents, in-situ burials, fused clusters, or empirical reconstructions based on numerical (clustering) techniques.

Current hypotheses about the form and function of the apparatuses, and hence the nature of the organism itself, center on whether some elements functioned as fused units for grasping or as members of an array of food-gathering and/or sieving digits and pectinate units, possibly in a lophophore. Bearing on these hypotheses are the questions. (1) Were all conodont elements always enveloped by soft tissue during life? (2) Do the fused clusters owe their fusion to biologic processes or to postmortem diagenetic mineralization? The question of biological affinity remains unresolved. However, recently discovered fused clusters suggest that fusion was diagenetic.

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History of Sulfidization of South Texas Roll-Type Uranium Deposit

Studies of the mineralogy, sulfur isotope geochemistry, and uranium-lead isotope geochronology of a roll-type orebody in the Felder deposit, south Texas, have indicated important constraints on the genesis of this deposit. Post-mineralization sulfidization of the host Oakville Sandstone (Miocene) resulted in precipitation of pyrite and marcasite in the altered tongue that differ in relative abundance and in isotopic composition from pyrite and marcasite elsewhere in the host rock. The altered tongue is characterized by a predominance of pyrite over marcasite and by heavy $\delta^{34}S$ values (−5.2 to +20.6 per mil), whereas reduced-barren and mineralized rock is characterized by abundant ore-stage marcasite and by light $\delta^{34}S$ values (−29.9 to −47.7 per mil). In reduced-barren and mineralized rock, two generations of pyrite are present: (1) pre-ore pyrite grains that are commonly enclosed by ore-stage marcasite; and (2) post-ore pyrite that is genetically equivalent to pyrite in the altered tongue. Resulfidization of the deposit by hydrogen sulfide-bearing solutions introduced along one or more nearby faults is indicated by the similarity in isotopic compositions of pyrite in the altered tongue to that of sour gas in the underlying Edwards Limestone (Cretaceous). The time of this resulfidization is probably indicated by the unusually precise $^{207}Pb/^{204}Pb$–$^{235}U/^{204}Pb$ isochron age of 5.09 ± 0.11 m.y. The lack of significant scatter of the points on the isochron diagram must reflect the immobility of uranium and lead over the last 5 m.y. due to the continued presence of hydrogen sulfide. The 5-m.y. isochron age indicates that no significant roll-forming processes have occurred in the Felder deposit since this time.

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Upper Cretaceous Mosby Sandstone, Central Montana—Example of Thin, Widespread Storm-Generated Sandstone Cycles

The Mosby Sandstone Member of the Greenhorn Formation is composed of thin (less than 6 ft or 1.8 m), very fine-grained to fine-grained sandstone cycles separated by shale. The sandstones occur either as individual beds, generally less than 1 ft (9.3 m) thick and separated by interbeds of shale, or as amalgamated beds. The base of each cycle is a planar to undulating ero-