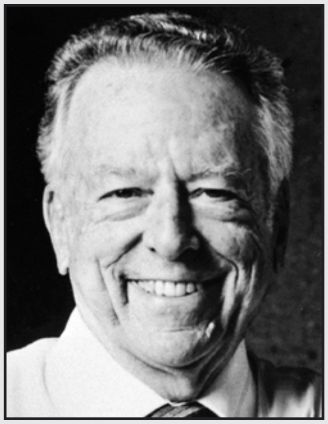
PENROSE MEDAL

Presented to George A. Thompson



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Citation by Mary Lou Zoback

Applying keen geologic insight to interpret diverse geophysical datasets, George Thompson has illuminated a broad range of crustal processes, profoundly enhancing our understanding of crustal evolution. Much like the man, his geophysical models are ingenious and elegant and always well-grounded in basic principles. Thompson contributions have stimulated research in four distinct thrusts:

- **Role of lithosphere buoyancy in surface elevation.** In 1964, Thompson and Manik Talwani used seismic and gravity data to demonstrate thin crust underlying the western U.S. Long before plate tectonics, they recognized that low-density upper mantle was required to explain the regional high elevation. Later, Thompson was among the first to establish the importance of lithospheric thickness in controlling continental elevation; with Tom Crough, using surface waves, he showed that a thinned mantle lid could explain the Sierra Nevada uplift.
- **Nature of the lower crust in extended terranes.** Interpreting gravity and seismic data, Thompson demonstrated that extension of upper crust in the Basin and Range must be balanced by influx of mass into the lower crust. This fundamental gravity constraint stimulated widespread research into the lower continental crust composition in extensional regions. In the 1980s, Thompson and students studied exposed sections of deep crust and uppermost mantle, demonstrating that interlayered mafic + ultramafic rocks (as in the Ivrea Zone) could explain the laminated, laterally discontinuous reflection character of the Moho on deep seismic-reflection profiles.
- **Brittle upper crust deformation.** Thompson pioneered quantification of orientation and rates of extension by measuring normal fault throw and subsurface configurations of faults. Parsons and Thompson showed that in volcanic terrains, brittle upper crust can extend by intrusion, without faulting—explaining relatively aseismic, low-relief terranes like the Snake River Plain. Offshore, Lachenbruch and Thompson demonstrated that the right-angle configuration of mid-oceanic ridges and transform faults represents a minimum energy configuration.
- **Plume tectonics.** Thompson's recent research has illuminated the unifying role of deep-seated mantle plumes in explaining continental extension/breakup, crustal creation/modification, and topography and isostasy.

Response by George A. Thompson

Thank you, Mary Lou, for your generous comments! I was stunned speechless when I heard about the Penrose. … But after brief consideration I decided to accept. I humbly accept as the representative of all those in the Geosciencee community whose creative insights continue to make Geology inspiring. They include many students,colleagues, mentors, my lifelong partner Anita, and our family. I cannot begin to name them all or even their institutions, but my appreciation is expressed by a quotation of unknown origin:

> "I have warmed by fires I did not build
> I have drunk from wells I did not dig"

Not that I haven't dug a lot of holes for myself—some really hard to climb out of!!

I was lucky in my first field experience to be assigned by the USGS to an often overlooked part of the Basin and Range province, a mining district in the Big Bend area of Trans-Pecos Texas. In this arid and mountainous terrain (Yes, Texas!), faults and intrusions are beautifully exposed in three dimensions and further explored in mines. But the processes that excited my curiosity are still with me; we have much to learn about the active crust and mantle machinery driving fragmentation of the Basin and Range province of western North America and similar regions around the world. I focus on the interplay of magmatic and tectonic processes on crust and mantle scales, and I am fascinated by the vigor and pace of current research. In the Nevada Basin and Range, for example, in addition to the long-running influences of subduction, arc magmatism, back-arc spreading, and San Andreas shearing, this actively spreading region received an enormous pulse of energy 16 million years ago with the eruption of hundreds of thousands of cubic kilometers of Columbia River flood basalts, emplacement of massive dikes from Washington State to southern Nevada, and the emergence of the Yellowstone Hotspot. Conceptually modeled as the breakout of a hot rising mantle plume (not without controversy!), the plume head also spread irregularly beneath the lithosphere for hundreds of kilometers. Combined gravity and seismic evidence are consistent with the widespread plume head. Now, growing evidence in the Nevada Basin and Range, based on thermochronology, demonstrates rapid pulses of mountain uplift and normal-fault extension at this same time, 16 million years. Clearly the Columbia River Basalt events had a major influence on Basin-Range structure. Hopefully, the processes operating here will supply a more general understanding of similar tectonic settings, such as the Dead Sea-Gulf of Aquaba, or perhaps the Triassic-Jurassic rifting and giant magmatic events of eastern North America.

Another example of coupled volcanic-tectonic products that cries for explanation is the astonishingly regular geometric pattern of ridges and transforms that decorate the ocean floors. Excellent observational and interpretive progress is growing rapidly, and competing explanations are numerous. An essential key to the self-organizing pattern, explored with colleague Tom Parsons, may be the active role of dikes, injecting and fracturing perpendicular to the least stress, like artificial hydrofractures but unlike normal faults, which are shear failures. The dikes inflate perpendicular to the least stress and in so doing change the stress. Field examples exhibit 90-degree changes in least stress direction. Rifting continental margins are marked by oblique and irregular normal faults, but dikes take control where magmatism dominates the new ocean floor, and dikes are probably the principal key to the self-organization of the near-orthogonal pattern.

Aside from the joys of Geoscience, I spend most weekends in hands-on management of a tract of California Coast Redwood forest. This is quite a learning experience! It is a productive working forest, managed to curtail development (by far the greatest threat to productive forests), managed to sequester carbon at maximum rates, and managed to reduce vulnerability to fire. Selection harvest leaves the land covered by forest at all times with trees of all ages, from seedlings to old giants. I strongly recommend that we re-think the preservationist model of treating U.S. forests (but that is a long story for another day). The redwoods tell a geologic story as well. Their pollen abundance in sediments records dramatic cycles in climate in the Holocene and especially in the Pleistocene.

In a final note, Geology shares with Astronomy a unique perspective of the vastness of time and space in relation to our tiny human niche—a spiritual dimension if you will. Unlike astronomy, geology is applicable to managing the Earth, its oceans and atmosphere. Perhaps we will even modify tectonic and volcanic events in the future. The general public is receptive, even hungry for more geologic information. I applaud the many excellent documentaries that help illuminate geology to the general public. But I think we have an opportunity beyond that, well illustrated by the astronomical spots ("Star Date") aired on commercial radio news broadcasts. They are very well done, current, and give the listener things to look for. The dynamic Earth offers great possibilities to build on this model!

Thank you warmly!