HGS LUNCHEON MEETING

Retrospective And Prospective Salt Tectonics

HGS Luncheon Meeting, May 25, 1994
Social Period, 11:30 a.m., Luncheon and Meeting, 12:00 Noon
The Houston Club

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RETROSPECT, *a contemplation of the past.*

The bulk of this presentation is a subjective historical review of the scientific progress and conceptual breakthroughs in understanding salt tectonics, including the origin and evolution of salt diapirs. The essence of each discovery and its implications will be presented in simple terms in order to cover the vast variety of salt structures as comprehensively as possible. The history of salt tectonics divides naturally into three succeeding eras: the Pioneering Era, the Fluid Era, and the Brittle Era.

The Pioneering Era (1856-1933) featured the search for a general hypothesis of salt diapirism, dominated by erroneous notions of igneous activity, in-situ crystallization, and expansive crystallization. During this era, salt domes were discovered together with their association with oil. The buoyancy hypothesis, erosional and sedimentary differential loading, and downbuilding were proposed.

The Fluid Era (1934-late 1980s) was dominated by the view of salt tectonics as Rayleigh-Taylor instability in which a dense fluid overburden with negligible yield strength sinks into a salt layer, displacing it upward. Density contrasts, viscosity contrasts, and dominant wavelengths were emphasized; strength of and faulting in overburden were ignored. Breakthroughs in this era include: structures within mined diapirs, the comprehension of peripheral sinks, turtle structures, and diapir families, flow laws for dry salt; recognition of salt upwelling below very thin overburdens, and the discovery of allochthonous salt sheets. The 1970s revealed the basic driving force of salt allochthons, intrasalt minibasins, the possibility of thermal convection in salt, direct measurement of salt glacial flow and its link with rainfall, the internal structure of convecting evaporites and salt glaciers, and the effects of tilted or wedge-shaped source layers and overburdens in all-fluid systems. The 1980s revealed salt rollers, salt canopies, mushroom diapirs, flow laws for damp salt, spoke circulation, and Rayleigh-Taylor instability combined with thermal convection. By this time, the awesome implications of increased reservoirs below salt sheets had stimulated a renaissance in salt-tectonic research.

Blossoming in the late 1980s, the Brittle Era is actually rooted in the 1947 discovery that a diapir stops rising if its roof becomes too thick. Such a notion was heretical in the Fluid Era. Stimulated by computerized reconstructions of Gulf Coast diapirs, by the multitude of faults revealed by ever-sharper seismic imaging, and by sandbox experiments, the onset of the Brittle Era yielded raft tectonics, salt welds and fault welds, salt welts, shallow spreading of salt sheets, salt flats and salt ramps, regional detachments marking vanished salt allochthons, and rules of section balancing for salt tectonics. The early 1990s have revealed reactive piercement as a diapiric initiator by tectonic differential loading, cryptic thin-skinned extension, the influence of sedimentation rate on the geometry of passive diapirs and extrusions, the importance of critical overburden thickness to the viability of active diapirs, roho systems, counter-regional fault systems, 3D linked extensional and contractional systems, subsiding diapirs, and extensional turtle structure.

PROSPECT, *outlook upon the probable future, probable source of profit*

After reaching the present state of knowledge, some emerging, and still-murky topics in salt tectonics will be discussed. These topics include the prospect of submarine salt glaciers, role of contraction in salt-sheet emplacement, cryptic thick-skinned extension, and distinguishing withdrawal synclines from buckling synclines.

MARTIN P. A. JACKSON - Biographical Sketch

Born and raised in Zimbabwe, Jackson received bachelor's degrees from the University of London in 1968 and 1969. After two years as an exploration geologist for Cominco in southern Africa, he obtained his doctorate in geology from the University of Cape Town in 1976 for his work on a high-grade metamorphic and igneous Precambrian terranne in the Namib Desert in Namibia. After four years teaching in the Department of Geology, University of Natal, South Africa, he joined the Bureau of Economic Geology in 1980. After a desperate Texas-wide search for something vaguely familiar, he was attracted to salt structures as low-temperature analogs of high-grade gneisses. He directs the industry-funded Applied Geodynamics Laboratory at the Bureau. In 1984, he was Visiting Scientist at Uppsala University, Sweden, where he first started modeling salt diapirism. He led an international team investigating the geology and dynamics of salt-diapir emplacement in Central Iran, published as GSA Memoir 177. He has received the George C. Matson Award and the J. C. Sproule Memorial Award (with S. J. Seni) from AAPG, and the Macgregor Medal from the University of Zimbabwe. He was an AAPG Distinguished Lecturer in 1991/1992 and has served as Associate Editor for AAPG Bulletin and GSA Bulletin. In 1993, he co-convened AAPG's Hedberg International Research Conference on Salt Tectonics in England, which included this talk.