WA Branch

Tectonic Models And Seismic Interpretation

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When data are not definitive, seismic interpreters turn to tectonic models; hence many structure maps, despite 3D seismic, are only as good as the current tectonic paradigm.

Theories of tectonic evolution of the Earth have spanned the full spectrum from contracting to expanding and we are currently experiencing another radical paradigm shift. Maybe we can best evaluate the potential benefits to the seismic interpreter by looking at the history of Earth models.

Taylor proposed in 1910 a partial closing of the Atlantic as an explanation to Tertiary folding.

In 1911 Baker showed a distorted reconstruction of all the continents into a single continent mass. But it was Wegener's extensive geological and geophysical knowledge which in 1912 enabled him to not only reconstruct all the continents but also to show that the continental and oceanic crusts are fundamentally different. The Taylor-Wegener theory of continental dispersal, as it came to be known, had few supporters.

Even though his reconstructions were not accurate (he had only a minor Eastern Tethys), Wegener was undoubtedly the founder of "plate tectonics". He attributed Pacific compression in the Andies and Indian compression in the Himalayas to the opening of the Atlantic and Indian Oceans on a constant radius earth. Most importantly, he recognised tensional normal faults in the East African Rift as a precursor to oceanic formation and hence also to basin formation.

Wegener's theory of continental dispersal was revived in 1945 by Carey who included Holmes' 1928 upper mantle convection (subduction) in his constant radius earth. Carey's success lay in part in his recognition of substantial horizontal continental motion, the bending of compressional orogenic belts in plan view.

Carey's Tethyan Shear between the northern, continental hemisphere and the southern, oceanic hemisphere and on an asymmetric earth emphasises the contribution of momentum and radial forces in global tectonics rather than mantle circulation required by plate tectonics. The answer probably lies between the two as suggested by Owens' 1976 reconstruction on an Early Jurassic Earth of 80% modern radius but which included considerable subduction.

The 1995 APEA Journal published my "Globally synchronous compressional pulses in extension basins", i.e. Hilgenberg-like basin inversion by upper crustal compression due to continental flattening (pulsed with Vail eustatic cycle chart), and contemporaneous basin formation by lower crustal extension.

3D seismic surveys are generally confined to individual fields and often the post-reservoir section is not available to the interpreter. This means the confirming wrench and compressional movements in the young section, reflecting earlier basin-forming faults, is often lost. The seismic interpreter must also be aware of the present regional compressional stress orientation in order to map the compressional features. Fortunately that direction appears to have varied little during the life of each basin despite major plate tectonic and expansion induced continental dispersal.

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