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Practical Consideration in Using Velocity, Frequency, and Phase in Stratigraphic Seismic Exploration

Since recent rediscovery of the role which amplitudes can play in seismic exploration, potential information content in other attributes has been suspected. Attempts to use these attributes have been directed essentially toward special problems (thin beds, fracture porosity) and/or special displays (instantaneous frequency, phase, etc). In fact, there are simple methods and displays which relate closely to more or less conventional approaches and make significant use of attributes such as velocity, frequency, and phase. The insights which can be developed are of particular value in stratigraphic studies, especially on land where amplitudes embody so much greater uncertainty.

Key results which can be readily established include an appreciation that large scale velocity changes are often directly indicated by stacking velocity slope changes. High frequency reflections can often delineate major changes in lithological sequence and point out with clarity "specular" reflecting boundaries such as lava sills and fluid contacts. Finally, study of phase properties makes clear that synthetic seismogram rather than the inversion section is the proper place to note phase differences and to make adjustments.

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Fan-Deltaic and Marine Siliclastic Facies of Laborcita Formation, Northern Sacramento Mountains, New Mexico

Fan-deltaic sequences in the Laborcita Formation, northern Sacramento Mountains, New Mexico, form a clastic wedge that prograded north and west. These Penn-Permian (Virgilian-Wolfcampian) deposits represent a facies tract of proximal to distal alluvial fan and fan-deltaic facies. Associated nearshore and shelf siliclastics are also developed.

Red bed conglomerates interpreted as braided and ephemeral fluvial channel fills are the most proximal deposits. These limestone cobble conglomerates crop out near the Fresnal Canyon fault and are syntectonic deposits. Northern quartzite cobble conglomerates are less proximal and form more continuous sheet-like units. These thick (10 m, 33 ft) and laterally extensive (6 km, 4 mi) conglomerates that contain trough cross-bedded coarse sand lenses associated with intrachannel bars are interpreted as midfan deposits.

Shales and thin (20-40 cm, 8-16 in.) progradational distal sands under conglomerates are highly variable in total thickness (20-60 m, 65-200 ft). The thin sandstones show evidence of marine processes and are interpreted as fan-deltaic foreset deposits. Gray limestone and chert conglomerates deposited directly on limestones are thin (0.5-2 m, 1.5-6.5 ft), deposited subaqueously, and exhibit reworking by marine processes.

Northern sands are disassociated with conglomerates. These green arkosic sands are relatively thick (3 m, 10 ft) and contain landward (east) accreting tangential foresets. Geometry, stratigraphic position, and minor upward coarsening indicate shelf-bar deposition.

Fan-delta source areas shifting during Laborcita deposition. Initial deposits were from the southeast and characterized by limestone/chert conglomerates. Later quartzite/rhyolite porphyry cobble conglomerates prograded from the east and northeast. Ultimately, alluvial fan red beds of the Abo Formation prograded over Laborcita fan-delta and shelf-bar deposits.

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Reexploration in Recôncavo Basin, Brazil

The Recôncavo basin, a major oil and gas rift basin in northeast Brazil, has reached exploration maturity relative to traditional structural trap prospects. The basin has gone through 2 phases: an initial phase from 1940 to 1960 when the major existing fields were discovered, and a development phase from 1960 to 1980, during which addition of new field reserves was small, recovery factors of the major fields were increased, and production decline began. In the early 1980s a third phase, one of reexploration, was initiated, with exploration oriented toward prospects not systematically tested before, and exploitation strategies aimed at increasing recovery from existing fields.

In the past, the exploration in Recôncavo was for structural highs with two targets: a basal Jurassic prerift fluvial section brought into structural contact with a core of lacustrine source beds, and a supra-core Cretaceous deltaic section that is part of the rift fill. Discoveries of stratigraphic traps in the intermediae turbiditic rift section were commonly fortuitous, made while testing structural highs. Current structural and stratigraphic analysis of this tract of the rift fill shows that it consists of turbiditic and non-turbiditic sublacustrine fans, and indicates that the more prospective areas tend to be the structural lows of the prerift section. A major element of the reexploration strategy is testing these combined structural-stratigraphic prospects in the rift section.

Ultimate recovery from existing Recôncavo reservoirs, based on conventional development practices, is estimated to be 33% of oil in place. An estimated 450 million m^3 (2.8 billion bbl) is left unrecovered, of which above 60% is residual oil requiring advanced tertiary techniques for recovery, and about 40% is a target for strategically deployed conventional recovery. Additional recovery depends on detailed reservoir characterization identifying isolated zones and internal heterogeneities that control fluid behavior. With these strategies, overall recovery can be increased from an average of 33-42%, leading to a doubling of current remaining reserves, rated at about 60 million m^3 (377 million bbl).

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Uranium Distribution and Sandstone Depositional Environments—Oligocene and Upper Cretaceous Sediments, Cheyenne Basin, Colorado

Wyoming-type roll-front uranium deposits occur in the Upper Cretaceous Laramie and Fox Hills sandstones in the Cheyenne basin of northeastern Colorado. The location, geometry, and trend of specific depositional environments of the Oligocene White River and the Upper Cretaceous Laramie and Fox Hills formations are important factors that control the distribution of uranium in these sandstones.

The Fox Hills Sandstone consists of up to 450 ft (140 m) of nearshore marine wave-dominated delta and barrier island–tidal channel sandstones which overlie offshore deposits of the Pierre Shale and which are overlain by delta-plain and fluvial deposits of the Laramie Formation. Uranium, which probably originated from volcanic ash in the White River Formation, was transported by groundwater through the fluvial-channel deposits of the White River into the sandstones of the Laramie and Fox Hills formations where it was precipitated.

Two favorable depositional settings for uranium mineralization in the Fox Hills Sandstone are: (1) the landward side of barrier-island deposits where barrier sandstones thin and interfinger with back-barrier organic mudstones, and (2) the intersection of barrier-island and tidal channel sandstones. In both settings, sandstones were probably reduced during early burial by diagenesis of contained and adjacent organic matter. The change in permeability trends between the depositional strike-oriented barrier sandstones and the dip-oriented tidal-channel sandstones provided sites for dispersed groundwater flow and, as demonstrated in similar settings in other depositional systems, sites for uranium mineralization.

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Turbidite Facies and Facies Associations of Cretaceous and Paleocene Gottero Sandstone, Northern Italy

Turbidites of the Gottero Sandstone were deposited as a small deep-sea fan in a trench-slope basin. The Gottero is as thick as 1,500 m (4,900 ft), had an original radius of 30-50 km (19-30 mi), and in the early and middle Cenozoic was thrust northeastward onto the Italian peninsula. The Gottero Sandstone is stratigraphically part of the Vara Supergroup, which has an ophiolite at its base and forms one of several stacked allochthonous sheets in the Ligurian Apennines southeast of Genoa. The Gottero, which contains foraminifers ranging in age from Albian to Paleocene that indicate deposition at bathyal depths, consists chiefly of feldspathic sandstone thought to be derived from the largely plutonic Corsican-Sardinian continental block to the southwest. The Gottero rests on tectonically disrupted shale that contains intercalated olistostromes. To the northwest, northeast, and southeast, it pinches out into and is overlain by basin-plain