(~0.7070). The brines are from 15 oil fields within an area of approximately 2,000 mi^2 (5,200 km^2); the isotopic variability shows no geographic pattern in the study area. The variation in $^{87}Sr/^{86}Sr$ ratios of brines occurs to a lesser degree within individual oil fields. For example, over a distance of about 10 mi (16 km) at Walker Creek, the isotopic ratios of 11 Smackover brines range from 0.7080 in the east to 0.7086 in the west.

The observation that Smackover brines are variably more radiogenic than Jurassic seawater is important because it indicates that a significant proportion of the Sr dissolved in these brines has been acquired from a source material that has not formed wholly by precipitation from Jurassic seawater. That is, some radiogenic Sr must have been added to the brines from a detrital source material. The nature and distribution pattern of the $^{87}Sr/^{86}Sr$ ratios indicate the acquisition of variable amounts of radiogenic Sr on a local basis. If the Smackover brines originated in the Louann Salt, with $^{87}Sr/^{86}Sr$ equivalent to that of Jurassic seawater, their present isotopic compositions may be the result of varying degrees of subsequent interaction with detrital sediments or they may have been produced by mixing in variable proportions with solutions containing more radiogenic Sr. Potential sources of the radiogenic Sr are the Norphlet Formation and the lower Smackover argillaceous lime-mudstone, both of which lie stratigraphically between the Louann salt and the upper Smackover, as well as the Bossier shale which interfingers with the upper Smackover in the North Louisiana salt basin. Anhydrites from the Werner and Buckner formations and from northern Louisiana salt domes, which constitute additional potential sources of brine Sr, yield $^{87}Sr/^{86}Sr$ ratios equivalent to those of Jurassic seawater.

Diagenetic phases of the upper Smackover, such as post compaction calcspar cement and baroque dolomite, have $^{87}Sr/^{86}Sr$ ratios more radiogenic than Jurassic seawater, suggesting their subsurface precipitation in Sr isotopic equilibrium with Smackover brines. However, ooids and oncolites from the upper Smackover lime-grainstone yield $^{87}Sr/^{86}Sr$ ratios indicating isotopic equilibrium with Jurassic seawater.

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Geologic Evolution of Precambrian Basement of Eastern Desert of Egypt

The Eastern Desert of Egypt contains an exposure of approximately 80,000 km^2 (30,000 mi^2) of late Precambrian basement between the River Nile and the Red Sea. The dominant lithologic units of the basement are low-grade basaltic and andesitic metavolcanics and immature metasediments. These are associated with serpentinite-gabbro units, which have been interpreted as fragments of obducted ophiolites, and large syntectonic diorite-tonalite-granodiorite intrusions. A regional unconformity separates the above units from a sequence of molasse-type sediments which are intruded by post-tectonic Pan-African (~580 m.y.) granites.

Geographic patterns of age, lithology, petrochemistry, and structure have been interpreted in terms of multistage development and accretion of intra-oceanic island arcs and intervening basins. The age of intrusions, and the depth of crustal exposure, generally increases toward the south. No evidence has yet been reported for ages greater than ~1,200 m.y., or unequivocally continental lithologies, among the older units.

Structural analysis suggests that the region was affected by at least two distinct compressional events. The first event involved compression along a northwest-southeast axis, and may be related to an episode of northwest-vergent folding and thrusting, with concomitant magmatic activity. The second event involved compression along a WSW-ENE axis which initiated uplift, molasse-type sedimentation, large-scale open folding along NNW-SSE axes, and WSW-directed thrusting or gravity sliding. The emplacement of the Pan-African granites and rhyolites apparently occurred upon relaxation of the second compressional event, signifying the maturation of the crust of the Eastern Desert of Egypt.

The dominant trends (NNW-SSE and WSW-ENE) of high-angle faults and fractures were well established by the end of the Precambrian. These seem to have controlled the positions of various Phanerozoic features, such as alkaline complexes, local sedimentary basins, and the Red Sea.

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Role of Neptunian Dikes in Structural Evolution of Reefs

Sedimentary dikes, mostly of the neptunian type, are common if not universal features of submarine carbonate buildups, particularly reefs, and also have been reported from submarine volcanic mounds and pelagic marine sediments. Most of the neptunian dikes occupy widened joints that exhibit clear evidence of tensional origin. Large neptunian dikes reported from Gotland, Sweden, from central Europe, and from the upper Wabash Valley region of the United States also exhibit multiple (polyphase) banding, suggesting repeated joint formation.

The largest dikes appear to occur only in the margins of reefs or other sediment mounds, suggesting an origin related to local sediment accumulation rather than to regional tectonic forces. Dike joints that occur in reef flank rocks of the upper Wabash Valley region exhibit both radial and concentric orientation with respect to reef centers, and most of the dikes are essentially vertical. The vertical dike crevices appear to be simple extension fractures, but the orientation of a few outward-dipping dikes and sills in some reefs is somewhat anomalous. The joint crevices which they occupy have the orientation of shear fractures, but probably represent extension fractures that were diverted from their initial vertical orientation by the inclined bedding of the reef flank rock.

The fact that most neptunian dikes are oriented vertically strongly suggests that principal compressive stress axes were oriented vertically throughout the development of reefs and other submarine mounds, which in turn suggests that the dike crevices probably were produced in response to gravitational load stresses developed within the mounds. The existence of both radial and concentric dike crevices in reefs suggests that the intermediate and least principal stress axes were oriented both radially and concentrically during reef development. This in turn suggests that the confining pressures of surrounding interreef sediment, and the internal cohesion within the reefs, were great enough to prevent reef expansion by concentric joint formation at some times, but not at other times. Relief of stress by reef expansion along concentric vertical fractures probably increased the likelihood of later expansion along the radial fractures.

Dike crevice formation probably is closely related to differential compaction or other differential volumetric changes that occurred within the reef parts, or that occurred between the reefs and the interreef sediments, but crevice formation also may have been affected to some extent by sagging of the sea floor beneath the reefs and other sediment piles.