Global Strike-Slip Fault System, Crustal Oxidation State, a New Plate Tectonic Paradigm, and Giant Resource Accumulations

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by Stanley B. Keith, Monte M. Swan, Jan C. Rasmussen, Daniel P. Laux MagmaChem, L.L.C.

Mexico Mega-Shear System and Crustal Oxidation State

A recent tectonic synthesis of Mexico metallogeny and tectonics using the magma-metal series approach uncovered some large-scale geologic phenomena that have implications for worldwide giant petroleum and metallogenic accumulations and also lead to a more fixistic global plate tectonic paradigm. The discovery occurred through the observation of regional crustal oxidation state patterns following completion of a oxidation state map for Mexico that was based on over 4,000 oxidation state control points. The oxidation state control points variously consist of ferric/ferrous ratios for plutons (about 400) and mineral assemblages and geochemistry from plutons and mineral districts that are empirically correlated with pluton oxidation states in a global controlled data base for about 5,000 correlated case histories.

Additionally, petroleum accumulations of all sizes globally correlate with source and reservoir rocks of low oxidation state where ferric-ferrous ratios are equal to or less than 0.6. In the Mexico region, over 500 oil and gas field occurrences were used to additionally constrain crustal oxidation state. Also, petroleum occurrences can regionally coexist with other commodities (such as diamond, gold, and tin, antimony, mercury, lithium, and tantalum) which require low oxidation states for their stability throughout the source-transport-deposition process. Consequently, maps of regional crustal oxidation state in any particular area are a necessary exploration tool for a given commodity.

The Mexico oxidation state map produced a striking zig-zag pattern that, when compared with an oxidation state map for the western U.S., indicates a southeastward offset of the inferred Cambrian craton edge for some 3500 km from Cajon Pass west of Los Angeles, CA to Guatemala City, Guatemala. This offset is accomplished on west-northwest striking fault elements that form a giant country-wide shear system, referred to as the Mexico mega-shear. The Texas zone forms the nothernmost structural element of the shear system and the Motagua/Polochic fault system forms the southernmost element. Fault elements within the shear system are defined by sharply telescoped oxidation state gradients, where at least two levels of oxidation state are crossed in very short distances. A similar pattern was found for the inferred Cambrian craton edge, which is comprised of offset segments of north-northeast-striking zones of telescoped oxidation states.

The overall pattern confirms the Sonoran Mega-shear concept originally proposed by Silver and Anderson, 1974. The overall sense of the displacement of the inferred Cambrian margin is along a line of approximately N50W trend. However, the individual offsets occur along east-west to west-northwest-striking, what appear to be deep-seated fault zones that traverse the entire country of Mexico and adjacent areas. If the 3500 km offset is restored and the Gulf of Mexico is closed, Mexico and Northern Central America form a nice southward-pointed mega-peninsula that fits neatly to the coast of northwestern South America, west of Columbia and Ecuador. This reconstruction neatly removes the notorious ‘Bullard-fit problem'.

The mega-shear system is not confined solely to the country of Mexico and adjacent regions. The individual fault elements in the Mexico mega-shear appear to extend outward into the Pacific Basin, where they link nicely with the Pacific oceanic fracture system between 18oN and 42oN. A similar, even more dramatic, connection is achieved when the Mexico mega-shear system is extended to the east-southeast, where it links, almost element for element, with the central Atlantic fracture system between the equator and a latitude of 18oN. In both the Pacific and Atlantic ocean basins, the oceanic ridge system displays an apparent left offset of some 3500 km, in accord with the offset on the Mexico mega-shear system.

The offsets in the Atlantic Basin and their presumed Mexican analogs are particularly provocative. At the southern end of the Atlantic shear system, large left-handed offsets of the Atlantic mid-ocean ridge along the Romanche fracture system match well with large offsets of the inferred Cambrian craton edge along the Motagua/Polochic/Cayman trough fault system from its initial position in the Chortis block of Nicaragua-Honduras. This large offset is matched by several minor 50 to 100 km offsets in both the central Atlantic and Mexico mega-shear. About two-thirds of the way traveling northward into both systems, another large offset occurs (Guinea fracture zones in the Atlantic and the Monterrey-Parras fracture system in north-central Mexico. A series of smaller offsets occurs until the northernmost offset of about 150 km (Barracuda fracture in the Atlantic and the central portion of the Texas zone in southwestern Arizona and southeastern California).

In terms of its present known global position, the Mexico mega-shear, when correlated with its Atlantic and Pacific analogs, goes halfway around the world extending for about 180 degrees of longitude and ranging from 18o to 25o of latitude in width. The total accumulated offset of 3500 km has incrementally occurred within the last 200 million years. Much of the offset occurred between 175 and 145 Ma, 125 and 85 Ma, and 56 to 38 Ma, based on interpretation of the ages of oceanic floor. These offsets in the ocean floor correlate with major tectonic events in Mexico, such as the Oxfordian opening of the Gulf of Mexico and the mid-Cretaceous formation of the Bisbee Trough in the north part of the Mexico mega-shear system, and the Eocene opening of the Cayman Trough and left-slip movements on the correlative Motagua-Polochic fault system throughout Guatemala.