Origin of diagenetic fluids in the SE Mexican oil fields

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Several world-class oil fields are located inland and offshore the Gulf of Mexico, SE Mexico. The host carbonates had a complex diagenetic history, including pervasive dolomitization, fragile and hydraulic fracturing and breccia formation, several generations of cement, anhydrite injection and late hydrocarbon impregnation. Dolomitization and related cements are controlled by major structures and primary sedimentary textures. Mesozoic tectonics were characterized by passive margin development and early salt mobilization; the Tertiary, post-Chixchulub tectonic history is marked by complex tectonics, due to an ocean-continent oblique collision, the formation of a Tertiary foreland basin and very active salt and clay diapirism. Several researchers link the salt diapirism to the mobilization and upflow of dolomitizing fluids, and a heat increase causing organic matter maturation and oil expulsion.

A fluid inclusions study of diagenetic cements (dolomite and calcite) samples taken from oil wells throughout the mesozoic sedimentary sequence was undertaken. Fluid inclusions were classified as two-phase brine-bearing (L_{AQ}-V), two-phase oil-bearing (L_{HC}-V); and poly-phase (L_{AQ}-L_{HC}-V-S). The petroleum inclusions belong to the "black oil" family, while the majority of aqueous inclusions are methane-depleted with salinities between 8 and 18 wt% eq. NaCl and no evidence of hypersaline brines. Halogen data obtained from both dolomite cement and late-calcite plot very close and parallel to the seawater evaporation trend in a Na/Br vs Cl/Br diagram, past the point of halite precipitation, clustering around the point of epsomite-sylvite precipitation. This excludes the involvement of secondary brines from the dissolution of salt diapirs. The salinities of the fluids are too low for this degree of seawater evaporation, indicating the evaporite-related fluids probably mixed with dilute, seawater-like fluids during diagenesis.

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In situ conodont thermometry: Did cooler oceans trigger the Great Ordovician Biodiversification Event?

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The Great Ordovician Biodiversification Event saw the greatest evolutionary radiations of life in Earth's history with the sudden explosion of marine bio-originations increasing family and genus numbers x3-4 fold. During this event, the marine Cambrian Evolutionary Fauna was replaced by more complex Palaeozoic and Modern Evolutionary Faunas, establishing the blueprint for today's marine lineages. A plausible cause for this event is now apparent – here we show that 'global' biodiversity patterns are strongly coupled to global climate change. Previously, Supergreenhouse conditions were thought to have prevailed during the Ordovician, with unrealistically hot ocean temperatures (50–70°C), or that seawater $\delta^{18}O$ was markedly different from today. We present a new $\delta^{18}O$ palaeoclimate record derived from conodont bioapatite analysed *in situ* using the *SHRIMP II* ion microprobe. Early Ordovician to Silurian conodonts from tropical Gondwana and Laurentia give internally consistent results within individual specimens, populations, and across geographically disparate sites thereby recording a global temporal trend. Three climatic regimes are evident in the Ordovician which coincide with known biodiversity patterns. Early Ordovician oceans cooled steadily (~40–30°C) over ~25 million years as pelagic clades emerged. From the Mid to Late Ordovician, temperatures stabilised at modern equatorial values (~28–32°C) providing unprecedented opportunities for marine groups to diversify and fully exploit the available ecospace. A rapid Late Ordovician fall in temperatures led to widespread extinctions during the Hirnantian glaciation, with modern equatorial temperatures restored by the Early Silurian. This new climate record with constant $\delta^{18}O$ seawater composition shows that fundamental step-changes in Ordovician biodiversity patterns are closely linked to global temperature changes.