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U-Pb and Th-Pb dating of diagenetic/hydrothermal phases in the pre-salt series, Angola offshore: implication for the paleo-thermal history during South Atlantic rifting

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Since the discovery of major hydrocarbon resources in the Brazilian margin, its west African counter-part and particularly the offshore central segment has been intensively investigated during the last decade. In this study we report the first U-Pb ages acquired on 3 key diagenetic/hydrothermal phases (calcites, dolomite and silica cements) encountered in the offshore pre-salt carbonate/clastic series (Chela and Cuvo formations, Aptian) of the Kwanza basin. Our results provide important constraints on the post-depositional history of fluid circulations in these formations and the thermal regimes associated with the opening of the South Atlantic Ocean.

Consistent U-Pb and Th-Pb ages of 112.5±2.8 Ma and 110.2±2.1 Ma respectively were obtained using isotope dilution and laser ablation for a fracture-fill calcite spar associated to early hydrothermalism and moderately hot fluids. Multiple dolomite cements were dated by laser ablation giving ages between 90 to 115 Ma that reveal a complex diagenetic history of pervasive dolomitization episodes of the main reservoir at relatively shallow burial. The silica cement (vein-filling chalcedony) yielded an isotope dilution age of 92±3 Ma, indicating that the bulk silicification occurred during Turonian time, some ~25 My after deposition, and is therefore not related to surficial microbial processes as previously thought.

U-Pb ages combined with fluid inclusion temperature data provide compelling evidence for elevated thermal regimes that developed early after deposition at relatively shallow depth. The age of the pervasive dolomitization episode, although imprecise, is tied to late the cretaceous period (Albian-Cenomanian) with evidence of hot fluids (ca. 150°C) circulation and oil migration that is at odds with conventional thermal history reconstructions from basin modeling. The heat pulse is triggered by sub-depositional magmatic/volcanic activity, which was previously recognized in pre-salt deposits of the northern Kwanza basin. This study illustrates that coupling U-Pb ages and fluid inclusion temperatures can bring invaluable information to reconstruct a more reliable thermal history of complex reservoirs such as the synrift-sag pre-salt deposits of the South Atlantic margins.