An integrated study of a case of complex hydrothermal diagenesis in a PreSalt reservoir offshore Angola

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The Lower Certaceous Pre-Salt deposits occurring along the margins of the South Atlantic Ocean constitute major targets for O&G exploration and have been under much scrutiny in the recent years. They are predominantly composed of continental carbonate/clastic formations deposited during the synrift and sag periods of the Atlantic Ocean opening, and have often been submitted to intense diagenesis with positive and negative effects. Unraveling the diagenetic history of such complex reservoirs reveals a difficult task because rift systems can be the locus of extreme and variable paleothermal regimes as well as widespread volcanism and hydrothermalism.

The study we report here focuses on the Pre-Salt interval of a reference well located offshore Angola, near a major Transform Fault Zone. A detailed petrography, fluid inclusions, isotope geochemistry ($\delta^{18}O$, $\delta^{13}C$, $Sr^{87/86}$) and U/Pb dating investigation was conducted. A variety of integranular and vein-filling cements were characterized, primarily comprising dolomite, silica (quartz, chalcedony) and calcite. The results indicate that the Pre-Salt reservoirs experienced paleo-temperatures in the range of 150-200°C, i.e. significantly hotter than present-day (~100°C). Combining U/Pb ages gathered on a few diagenetic cements with fluid inclusion temperatures documents the existence of a heat pulse early after deposition, and permits to place constraints on the timing of hydrocarbon emplacement. The fluid inclusion and isotope data further show that cement-forming fluids were ^{18}O-rich highly saline brines of hydrothermal, most likely deep, origin. In addition, the ubiquitous occurrence of primary/secondary CO_2 gas inclusions in diagenetic cements records multiple pulses of CO_2 influx, concomittant with the development of transient elevated paleo-pressures (up to 900 bars) in fractures/veins. This is consistent with prevalence of CO_2 as the primary present-day reservoir pore fluid.

The studied Pre-Salt reservoirs in the deep offshore domain of Angola have been affected by intense hydrothermal diagenesis, most likely related to a specific structural context bordering a major Transform Fault Zone.