Petroleum Systems in the Geneva Basin: Insights From Basin Modeling

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ABSTRACT

The future provision of energy is challenging the scientific community in Switzerland. Conventional petroleum exploration that took place in Switzerland and neighbouring France in the past century did not reveal the occurrence of major petroleum accumulation below the Molasse basin, despite numerous oil and gas shows at the surface and in the subsurface. However, and as long as unconventional resources represent a major new source of energy, the potential discovery of unconventional oil an gas at depth sharpened many concerns in the past few years, in particular after the discovery of a tight gas accumulation in Paleozoic rocks near the Geneva Lake. In order to investigate the petroleum potential of the Molasse basin around Geneva, tens of samples made of cuttings, core fragments and plugs have been gathered from several wells in the southwestern Molasse Basin in which two major source-rocks in particular have been analysed: the Posidonia shale (Lower Jurassic) and the Permo-Carboniferous sensu lato. An evaluation of the organic geochemistry of these potential source-rocks (TOC, maturity, biomarker analysis, gas chromatography and isotopic analysis) has been realized both on well samples and bitumen and gas seeps occuring at the surface. Two source-rocks are currently generating hydrocarbons at depth. While most of the Posidonia shales hold a rather low amount of organic matter (<0.7%), an interval of about 12m in the Humilly-2 well show high organic content up to 4% TOC. Geochemical analyses show that the Posidonia shale formation below the Geneva Basin is currently in the oil window thus mature enough to generate oil and very few gas. Biomarker analyses of bitumen seeps in the Geneva canton reveal their origin from the Posidonia shale. The Permo-Carboniferous beds made of coals intercalated in sandstones have reached the oil and gas condensate windows. Gas retrieved from an hydrocarbon pocket in the freshwater molasse unveil a biogenic and thermogenic origin. So far, the isotopic composition of the gas seems to indicate that it most probably originate from an early mature Type III precursor. 1D and 3D BPSM simulation endorse the source-rocks maturity and predict gas generation for the Posidonia shale and Permo-Carboniferous coals in the deepest parts of the basin. The occurrence of several strike-slip faults control the migration pathways of hydrocarbons. The potential of unconventional petroleum accumulation are discussed below the Geneva basin.