Pb isotopic constraints on multi-stage fluid migration; implications for hydrocarbon exploration in Lusitanian Basin (Portugal)

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Pb isotope compositions for three sample sets of pyrite in NNW-trending fracture arrays that crisscross Lower Jurassic hemipelagic series at S. Pedro de Moel region [1] indicate similar fluid sources and multiple migration events. Indeed, the $^{207}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ ratios, as well as μ-values, are relatively homogeneous, ranging from 15.641 to 15.778, 38.498 to 38.933 and 9.8 to 10.4, respectively; differences in $^{206}Pb/^{204}Pb$ ratios separate the three sets. The calculated μ-values and the relative position of samples in the uranogenic Plumbotectonics diagram indicate Pb derivation from upper crustal reservoirs. Identical $^{207}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ but variable $^{206}Pb/^{204}Pb$ ratios suggest that Pb was remobilized similarly but in distinct events, subjected to alike rock-fluid interaction(s) and/or migration pathway(s). The linear trend put in evidence for each set of samples intersects the Stacey-Kramers growth cruve at different ages: *ca.* 152 Ma, 59 Ma and 30 Ma. These ages correlate well with some major events experienced by the Lusitanian Basin during its geodynamic evolution, as documented in several studies [2], i.e.: i) main rifting stage in Late Jurassic times (Kimmeridgian); ii) regional uplift at the Upper Cretaceous-Paleogene transition, after a relatively long transient inversion period; and iii) effective tectonic inversion during the Pyrenaic phase of the Alpine Cycle. Accepting this interpretation, the fluid flow events recorded by pyrite infillings should compare with those related to hydrocarbon migration within basin. However, two contrasting consequences arise: i) if hydrocarbons were already generated but confined to the source rock(s), those events could have triggered their migration to potential reservoirs; ii) if reservoirs were already infilled, such events might have provided significant hydrocarbon leakage.

[1] Duarte et al. (2012), J Petrol Geol, 35(2), 105-126
[2] Wilson et al. (1989), AAPG Mem, 46, 341-362