Gas-dominated products of hydrocarbon generation at the early and middle stages of coalification: Xujiahe coal measures in central Sichuan basin

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Coal-measure source rocks with type □and type □ organic matter in fluvial-swamp facies and lacustrine-swamp facies developed widely in Xujiahe formation in the Sichuan basin. Usually, type□ and □kerogens generated mainly oil in the oil window, while type □ kerogens generated mainly gas and little oil at the early and middle stages of coalification (equivalent to the oil window with R_o from 0.7% to 1.3%). The R_o(R_o =0.8%-1.3%, Fig.1) is not high in general and is at early-middle mature stage in central Sichuan area where most of the discovered fields are gas fields, and Guang'an gas field is the biggest one among them where most of the wells produce gas. For example, more than 90 percents of the wells in Guang'an and Hechuan gas field are pure gas wells, and some gas wells containing condensate have high gas-oil ratios, from 150 to 4600.The hydrocarbon composition of natural gas is mainly CH_4, and the content of heavy hydrocarbon gas (C_{2+}) is high. And most of the dryness($C_1/(C_1 \sim C_5)$) are less than 0.95, so the natural gas is mainly wet gas. Most of the wells have no or little H_2S, which means there is no oil and gas interfused from the lower marine beds. The $\delta^{13}C$ values of methane, ethane, propane and butane are of -44‰~-33‰, -29‰~-22‰,-23.3‰~-28.6.‰, -21.1‰~-27.1‰, respectively, indicative of typical coal-related gas. The gas was generated from the coal-measure source rocks in the Xujiahe Formation and there was no gas generated from source rocks with sapropelic organic matter in the lower beds, which indicate gas-formation dominated hydrocarbon generation at the early-middle stages of colification.

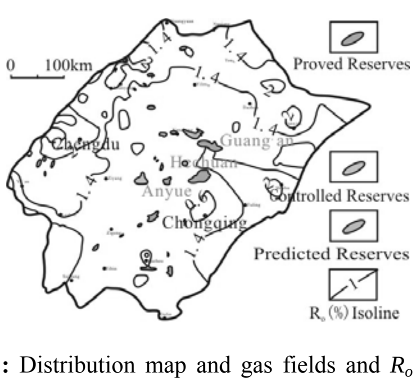

Figure 1: Distribution map and gas fields and R_o isoline of source rocks in Upper Triassic Xujiahe Formation in Sichuan Basin

[1] Dai(1992).*Sci. in China,Ser. B,* **35**(10), 1246-1257.

Quest for primary carbonatite melts beneath cratons: A West Greenland perspective

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Although considerable debate exists about the nature of primary mantle-derived carbonatite melts, there is consensus that they play a major role in mantle metasomatism including diamond formation. The recognition of carbonatite metasomatism in peridotites is based on the geochemical features of carbonatites found at the Earth's surface such as strong REE enrichment and relative Zr-Hf depletion. However, trace element enrichment factors calculated from new high-P partial melting experiments suggest that these 'hallmark' characteristics may not correspond to trace element features of primary carbonatitic melts in the mantle and that the majority of surface carbonatites acquired the extreme trace element features during differentiation processes instead [1].
A small number of carbonatites are associated with carbonate-rich ultramafic silicate magmas (aillikites and kimberlites) and these occurrences play a key role in addressing the nature and origin of primary carbonatite melts beneath cratons. Here we present new data on the petrology and geochemistry of the North Atlantic craton carbonatite-aillikite-kimberlite association with particular emphasise on the newly discovered Jurassic Tikiusaaq intrusion, West Greenland. Several lines of evidence including bulk-rock Sr-Nd-Hf-Pb and O-C-Li isotope data suggest that the dolomite-bearing carbonatites were derived from hybrid carbonate-silicate ultramafic magmas reminiscent of aillikite. Our model invokes carbonate liquid separation from proto-aillikite melt at uppermost mantle pressures triggered by crystallization of olivine and phlogopite, which form cumulates. This process alone is capable of elevating the REE concentration levels in the carbonate-rich liquid by an order of magnitude. Furthermore, upon crustal emplacement, fractionation of typical carbonatite accessory minerals such as baddeleyite and pyrochlore greatly affect the trace element features of the magma and thereby produce many of the so-called 'hallmark' carbonatite trace element characteristics.

[1] Foley *et al.* (2009) *Lithos*, in press.