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Genesis of the sandstone-hosted Baxingtu uranium deposit in the Songliao Basin, NE China

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The Songliao Basin, located in NE China, as part of the world-class Central Asia Uraniferous Province [1], was developed during the late Mesozoic continental extension in eastern Asia [2]. Sandstone-hosted uranium deposits such as the Qianjiadian [3] and the Baxingtu deposits were discovered in the southwestern part of the Songliao Basin, within the Kailu Sub-basin. The uranium mineralisation in the Baxingtu deposit occurs at the redox interface between secondary oxidised and primary reduced sandstones of the late Cretaceous Yaojia Formation [4]. The tabular ore bodies are mainly hosted within medium- to fine-grained grey/light grey channel sandstones, which were deposited within a braided river environment.

Drill cores of the host sandstones (including regional and ore reduced, mineralised and oxidised samples) have been investigated with emphasis on petrographic observations, whole-rock geochemistry, and geochemical and/or mineralogical study of Fe-Ti oxides, iron disulphides, uranium minerals (EMP, LA-ICPMS), and organic matter (rock-eval pyrolysis). The $\delta^{34}S$ values have been measured in situ by SIMS on the different populations of iron disulphide.

The regionally primary reduced sandstones are characterised by Fe_2O_3/FeO ratios < 1 (mean value = 0.54; n = 15), low and variable total organic carbon (TOC) contents ranging from 0.02 to 2.37 wt.% (TOC_{mean} = 0.29 wt.%; n = 15) and pre-ore U concentrations ranging from 1.74 to 16.90 ppm (U_{mean} in whole rock = 7.63 ppm; n = 15) that can be associated with diagenetically altered Fe-Ti oxides (U_{mean} = 350 ppm; n = 13), organic matter and clay minerals and thus may constitute a significant source of uranium for the deposits. Petrographic observations and rock-eval data indicate that organic matter within the reduced sandstones is mainly inherited from land plants and corresponds to type III and type IV kerogens. Ore-stage iron disulphides dominantly occur as framboids and in replacement of the organic matter, they show moderate to high concentrations of As, Cu, Ni, Co, Mo and Sb, and have a light sulphur isotope signature characterised by $\delta^{34}S$ values ranging from −72.0 to −6.2‰ suggesting that sulphur originated from bacterial sulphate reduction (BSR). The uranium mineralisation mainly occurs as pitchblende and coffinite: (i) in very fine admixture with iron disulphides or as nano-to micro-crystals associated with framboids; (ii) disseminated within the clayey matrix; and (iii) in replacement of organic matter or residual Ti-Fe oxides. High U concentrations also occur directly on the organic matter (median value = 0.3 wt.% U; n = 32). Contrarily to what has been described in the Erlian Basin [5], no replacement of iron disulphides by U minerals was observed. Iron disulphides and the U mineralisation are finally cemented by Fe- and Mg-rich carbonate. Therefore, this study suggests that uranium along with sulphates and bacteria were brought by oxygenated groundwater through the host sandstone, uranium was at least partly remobilised from it, and then was precipitated together with sulphides during the

BSR. Similar BSR-related U deposits that were characterised in the Erlian and Ordos basins in NE China [5; 6] further support this biogenic model.

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