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Paleovalley-related Uranium: Case-studies from Australia and China

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‘Paleovalley-related’ uranium deposits encompass three categories including variants of ‘sandstone-hosted’ deposits, as well as surficial deposits - referred to as ‘calcrete’-type, and lignite-type (Fig. 1; Hou et al., 2007).

Age	Ma	SANDSTONE		LIGNITE		CALCRETE	
		Australia	China	Australia	China	Australia	China
Cenozoic	Quaternary						
	Holocene						
	Pleistocene						
	Pliocene	U • Eucla Basin				U • Yeelrie D	
	Neogene	U • Lake Eyre Basin				U • Lake Way D	
	Miocene	U • Eucla Basin				U • Maitland D	
	Oligocene	U • Lake Eyre Basin				U • others in W.A.	
	Paleogene	U • Eucla Basin					
	Eocene	U • Eucla Basin					
	Paleocene	U • Pirie Basin					
Mesozoic	Cretaceous						
	Late	U • Carnarvon Basin					
	Early	U • Songliao Basin					
	Jurassic	U • Eromanga Basin					
	Triassic	U • Ordos Basin					
Paleozoic	Permian						
	Carboniferous	U • Ngalia Basin					
	Devonian	U • Amadeus Basin					
	Silurian	U • Canning Basin					
	Ordovician						
	Cambrian						

Fig. 1. Distribution of sandstone, lignite and calcrete-hosted uranium deposits in Australia and China through geological time (for the deposits located in the basins/regions see Fig. 4), and age-ranges (grey vertical bars) of the three types of paleovalley-related deposits worldwide. Note: for these three deposit types the ages shown are those of the host rocks.

The term ‘paleovalley-related’ implies more than just uranium hosted within a paleovalley. This style of uranium mineralisation can be defined as any diagenetic/epigenetic concentration of uranium minerals occurring in fluvial, alluvial, lacustrine, and estuarine sediments. Cenozoic paleovalleys of Australia, and Mesozoic paleovalleys of China host the greatest number of uranium deposits and include the largest and highest grade deposits of this type. Uranium exploration and mining in Australia and China are significant and increasingly important sectors of each country’s respective mineral industry. Here we focus on similarities in the geology of paleovalley-related uranium mineralising systems, which can be used

to refine common approaches to exploration. Paleovalley-related uranium resources are developed as sandstone-hosted and surficial deposits within paleovalley-fills, either incised into crystalline bedrock, or into sedimentary cover that often is of similar age to strata that host the mineralisation (Figs. 2, & 3). With respect to Sino-Australian examples, paleovalley-related uranium occurs mostly around the margins of Mesozoic and Cenozoic basins; often the mineralisation is hosted within sands contained within paleovalleys developed upon, or proximal to, Precambrian crystalline rock that contains primary uranium mineralisation (Hou et al., 2007; Li et al., 2008).

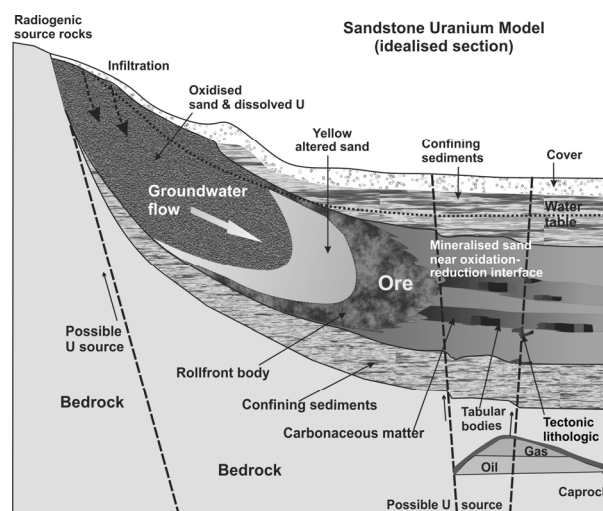


Fig. 2. Generalised conceptual model of sedimentary uranium deposits, highlighting the role of aquifer flow and REDOX state (e.g., Devoto, 1978), formation of roll-front mineralisation and the stratigraphic relationship of tabular, tectonic lithological and lignite uranium mineralisation.

Numerous examples are known in Australia and China where granitic rocks of pre-Mesozoic age contain uranium in the range 10–100 ppm, concentrations significantly above the crustal average of 2.8 ppm uranium. Radiogenic

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crystalline strata that are incised by paleovalleys are often the inferred source of the sandstone-hosted uranium. Weathered basement rocks in these regions were commonly incised by extensive fluvial systems, developed particularly during the Mesozoic and early Cenozoic, which acted to physically disperse uranium into the cover sediments, combined with chemical remobilisation, dispersion and concentration of uranium throughout the later Cenozoic.

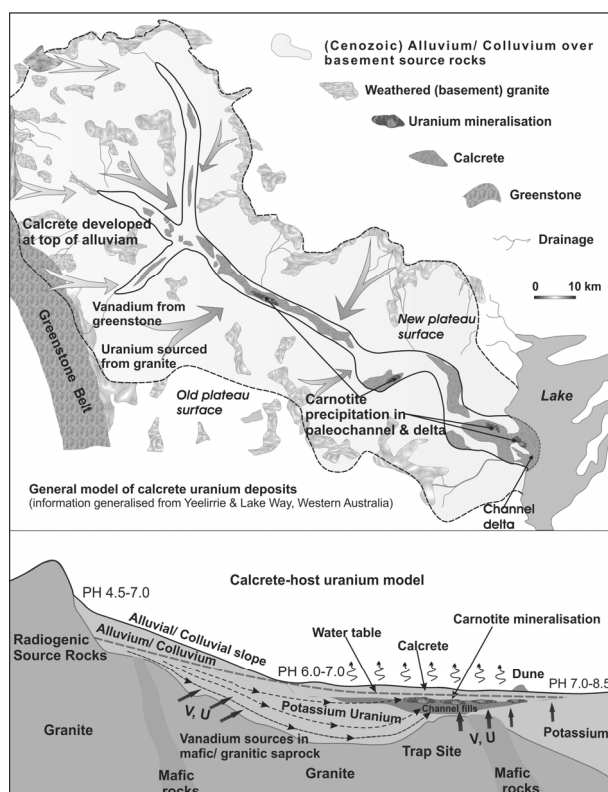


Fig. 3. Generalised model of valley-fill calcrete-hosted (carnotite) uranium mineralisation, based on Yeelirrie and Lake Way deposits, Western Australia (modified from Mann and Deutscher, 1978).

Paleovalley-related uranium deposits are typically hosted within unlithified sand, lignitic clays or calcreted channel-fill, deposited in continental or marginal marine environments. Sandstone-hosted uranium deposits invariably contain impermeable clay layers, intercalated within the sedimentary sequence; impervious layers often form the upper and lower bounding strata of individual deposits. Uranium deposits are associated with reduced lithologies; mineralisation is developed where oxidising fluids (carrying dissolved U) were modified by interaction with reduced sands, the latter commonly containing pyrite and dispersed organic matter and/or seams of lignite. Mineralised bodies, often tabular or roll-shaped, formed along the interface between clay horizons and the sandy

facies of paleovalleys. Geological, geophysical and geochemical features of the paleovalleys and related uranium deposits have been used to construct models to understand ore genesis and assist exploration for paleovalley-hosted uranium deposits. Australia and China remain highly prospective for the discovery of new paleovalley-related uranium deposits (Fig. 4). The precise geometric definitions of the basin margin and paleovalley architecture are important in identifying exploration targets and improving the effectiveness of drilling. This requires the integration of various geoscientific data sets. Refinements in remote sensing, geophysical techniques and data processing, in combination with sedimentological and depositional interpretations, provide an efficient approach for outlining the principal drainage patterns and channel dimensions (Hou et al., 2012). To help reduce risk, an exploration strategy should combine these technologies with a detailed understanding of the physicochemical parameters of uranium reduction, mobilisation and preservation.

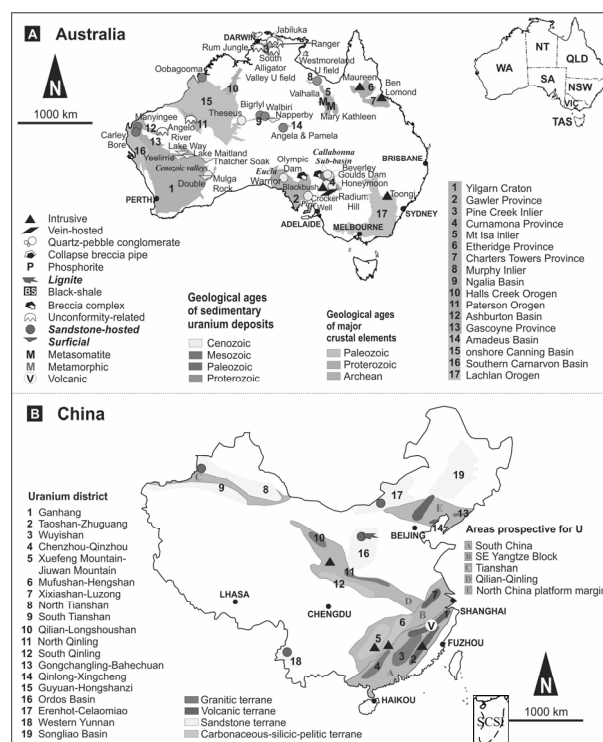


Fig. 4. Main uranium deposits/metallogenic regions in (A) Australia and (B) China (modified from Kreuzer et al., 2010; Zhang and Li, 2008).

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