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PALAEOVALLEY, PALAEODRAINAGE, AND PALAEOCHANNEL – WHAT'S THE DIFFERENCE AND WHY DOES IT MATTER?

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Abstract

Ancient river systems are a prominent feature of the Australian landscape and they host and obscure significant mineral and water resources. To date their nomenclature has been confused and inconsistent. Not all palaeovalleys are formed by rivers; some may be of glacial or tectonic origin. Nor is their fill always fluvial; in may be volcanic glacial, aeolian, or lacustrine. The nomenclature of these features must reflect their actual origin and evolution if their significance is to be properly understood. I propose that 'palaeoriver' be used for the ancient fluvial system responsible for a particular feature, 'palaeodrainage' for the network of palaeorivers, 'palaeochannel' for the channel formed by the palaeorivers, 'palaeochannel deposits' for the sediments that infill the palaeochannels, and 'palaeovalleys' for valleys incised by the palaeorivers. 'Inset valley' should be used to describe a particular palaeovalley profile and not used for palaeovalleys in general. Terms such as 'deep lead', 'prior stream' and 'ancestral river' should not be used, in the interests of consistency and clarity, especially for international audiences.

KEY WORDS: Geomorphology, regolith, landscape evolution, palaeovalley, palaeochannel, palaeodrainage.

Introduction

Valley and channel fill deposits are a common feature of the Australian landscape and of considerable economic significance. They host gold, uranium, and other deposits (Morgan 1993) and are major groundwater resources for both remote locations and irrigation areas (e.g. Clarke & Reisz 2004). Maps of their distribution (e.g. Hou *et al.* 2007b) provide important pre-competitive data for exploration companies, especially those interested in alluvial (e.g. gold, diamonds) and uranium (both rollfront and calcrete-hosted) deposits. These features are also important in the distribution of salt stores in the landscape (Commander *et al.* 2001, George *et al.* 2004).

These features have been given a plethora of names. Representative examples of Australian nomenclature include: deep leads (used by the miners and some to the present day, e.g. Holdgate *et al.* 2006), palaeochannels (Mazzucchelli 2005), palaeodrainage (van de Graaff *et al.* 1977), inset valleys (De Broekert & Sandiford 2005), palaeodrainage channel (Clarke 1994a, b), and palaeorivers (Beard 1999). Examples of diverse usage for the same features include 'palaeodrainage channel' and 'palaeodrainage' for features on the Yilgarn Craton (Clarke 1994a, b), 'palaeovalley' (Hou 2003a, b) and 'palaeochannel' (Hou *et al.* (2007a) for features on the Gawler Craton, 'palaeochannel' to describe both incised valleys and channels within a sedimentary succession (Anand and Paine (2002), and 'palaeochannel' and 'palaeodrainage' (Alley *et al.* 1999).

Why does it Matter?

Does this diversity of nomenclature matter, does it reflect a useful diversity of terminology for similar features or does it confuse important differences? Is a clarification of terminology helpful, or just nit-picking?

From the perspective of someone who has contributed to this confusion (see references above) I argue that a systematic terminology is critical as the implications of the different terms are quite different and misuse may give rise to false expectations. Consider the following illustrative examples:

> Example 1: A bedrock valley incised by a river and lacking in alluvial sediments is infilled by non-channel material, such as aeolian sediments or lava. Calling such a feature a 'palaeochannel' is misleading. It is not a channel, but an infilled valley. The absence of channel facies in the palaeovalley succession would render exploration in them for channel-hosted deposits, such as roll-front and calcrete uranium, or alluvial-diagenetic gold, futile.
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> Example 2: A bedrock valley incised by a river flow is infilled by fluvial sediment which include non-channel as well as channel facies. In some cases the non-channel facies may have composed the majority of the infilling sediments. Calling this feature a 'palaeochannel' is misleading, as it is implies a unity of feature which is absent. Rather than the feature having one primary target for channel-hosted deposits, such a feature would have many.
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> Example 3: A regional map shows features called 'palaeochannels'. Without more specific terminology, it would be impossible to distinguish between fluvially-incised palaeovalleys with fluvial infill, fluvially-incised palaeovalleys with non-fluvial infill, non-fluvially incised palaeovalleys with fluvial infill, palaeochannels within fluvially incised palaeovalleys, and palaeochannels exhumed from within basin sedimentary successions, all of which can occur within a single feature. The distinction is important for exploration companies seeking to take up new ground. Alluvial gold or gemstone deposits would be mostly found in channels at the bottom of palaeovalleys, along the basal unconformity. Roll front uranium deposits can occur throughout the succession provided there are suitable traps in reduced sediments. In Australia, calcrete uranium deposits occur near the present land surface in shallow palaeovalley or palaeochannel successions. Correct terminology in maps, such as those supplied by government agencies, can save valuable time for companies seeking the most prospective terrain.

Suggested terminology and its usage

To avoid such confusion of terms I suggest the following nomenclature be followed:

Palaeovalley refers to an ancient valley that may, or may not, contain palaeochannel sediments. Palaeovalleys are commonly fluvial (van de Graaff *et al.* 1977, Beard 1999), glacial (Eyles & de Broekert 2001), or tectonic (e.g. the Tamar & Derwent Vallies, Baillie 1989) in origin. Palaeovalley fill include glacial, fluvial (both channel and non-channel facies), lacustrine (Clarke 1994a), marine (Clarke *et al.* (1996), volcanic (Holdgate *et al.* 2006), and aeolian in nature, and some or all of these (such as in the Lefroy and Cowan palaeovalleys, Clarke 1994a, b, Clarke *et al.* 1996) in combination.

Palaeorivers are the ancient rivers that once occupied fluvial palaeovalleys (Beard 1999), or which deposited ancient basinal fluvial successions (e.g. Chakrabarti & Mukherjee 1997).

Palaeochannels are the channels of palaeorivers. They may occur at the contemporary land surface (Page *et al.* 1996), or in the subsurface (Harris 1980). They may be marked by channel forms or be infilled by palaeochannel deposits. Palaeochannel should be used in place of historic terms such as "prior streams" (Stannard 1962) and 'ancestral rivers' (Pels 1964) in the interests of clarity (especially for an international audience) and consistency.

Palaeochannel deposits may occur at the present land surface, infilling channels (Page *et al.* 1996) may occupy palaeovalleys or occur as channel deposits within basinal successions (e.g. Harris 1980). A single palaeovalley may contain several palaeochannels, as the palaeoriver, or rivers, changed course over time during aggradation of sediment. Other examples include the palaeochannels of the Eyre Basin (Alley 1988, Alley *et al.* 1999) or those that host uranium mineralisation at Beverley (Heathgate 1998).Palaeochannels can be exhumed and form inverted relief (McAlley & Wilson 1995, Harris 1980).

Palaeodrainage refers to an ancient drainage network made up of palaeorivers, occupying palaeovalleys in erosional landscapes and palaeochannels in depositional landscapes (van de Graaff *et al.* 1977).

Inset valley is an excellent descriptive term that captures the morphology of many palaeovalleys in Western Australia and elsewhere which consist of a broad valley form with a narrower more deeply incised section in the deepest part (de Broekert & Sandiford 2005). It should not be used as a more general term for palaeovalleys as not all palaeovalleys have this specific profile.

Deep lead is a mining term that should not be used for geological or geomorphological description. Its contemporary geological use is geographically restricted to Australia. It should be avoided where possible, except in a mining context.

Conclusion

There has been a number of good examples of a systematic use of an internally consistent terminology, including case studies from industry (Bampton *et al.* 2001, Heathgate 1998), academics (Hill *et al.* 2003), and government agencies (Hou *et al.* 2003a, b). This discussion is intended to encourage such good practice in the future. Using a correct nomenclature consistently will assist in understanding the significance of these features in mineral exploration, groundwater resource delineation, and for deciphering landscape evolution.

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