De Grey Superbasin and Fortescue Basin in the Pilbara: can they be compared with the Witwatersrand Basin?

by

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Introduction

In July 2017, Artemis Resources, in Joint Venture with Canadian explorer Novo Resources Corp., reported the discovery of an 11 m thick gold nugget-bearing conglomerate extending for 8 km at the base of the Mount Roe Basalt at Purdy's Reward in the northwest Pilbara (Fig. 1; Artemis Resources, 2017a). Artemis subsequently reported the discovery of gold in conglomerate at Mount Oscar 20 km to the northeast, giving rise to the current 'Pilbara gold rush' (Artemis Resources, 2017b). Considerable publicity was generated in September 2017 by a video cross from Purdy's Reward live to the Denver Gold Forum (Artemis Resources, 2017c). There are now numerous explorers and prospectors investigating the base of the Fortescue Group across the Pilbara (including De Grey Mining Ltd, Coziron Resources Ltd, Calidus Resources Ltd, and Venturex Resources Ltd, among others).

The discoveries have reignited speculation that an equivalent of the highly mineralized Mesoarchean to Neoarchean (3075–2715 Ma) Witwatersrand Basin in South Africa can be found in the Pilbara Craton. This is consistent with the concept of an Archean 'Vaalbara' continent that may have included both the Kaapvaal Craton, on which the Witwatersrand Basin sits, and the Pilbara Craton (e.g. Cheney, 1996; Zegers et al., 1998; Wingate, 1998; de Kock et al., 2009, 2012).

De Grey Superbasin and Central Pilbara Tectonic Zone

Any reconstruction of Vaalbara, attempting to match depositional units and settings, mineralized horizons, structures and tectonic settings in the Witwatersrand Basin (e.g. Robb and Meyer, 1995; Manzi et al., 2013; Tucker et al., 2016), must take account of the well-known geology of the Pilbara Craton and the Fortescue and Hamersley Basins (e.g. Huston et al., 2000; Smithies et al., 1999, 2001; Thorne and Trendall, 2001; Hickman, 2016). The Geological Survey of Western Australia (GSWA), collaborating with Geoscience Australia, published extensive 1:100 000-scale mapping, accompanied by new SHRIMP U–Pb zircon geochronology and geochemistry, during comprehensive remapping of the Pilbara in the 1990s and early 2000s (Hickman et al., 2006, 2010; Van Kranendonk et al., 2006, Hickman and Van Kranendonk, 2012; Hickman, 2016).

During the Mesoarchean, the northwestern part of the Pilbara Craton (Fig. 1) evolved through a plate tectonic cycle of subduction, accretion and collision, leading to cratonization at c. 2900 Ma. The De Grey Superbasin represents extension and subsidence following collision of the 3270–3120 Ma West Pilbara Superterrane with the older (3525–3225 Ma) granite–greenstones of the East Pilbara Terrane during the 3070–3060 Ma Prinsep Orogeny (Fig. 2). The superbasin includes the c. 3020 Ma Gorge Creek Basin, the c. 3010 Ma Whim Creek Basin, the 2970–2940 Ma Mallina Basin and the c. 2930 Ma Mosquito Creek Basin. The Gorge Creek, Whim Creek and Mallina Basins overlie a regional unconformity and form part of the Central Pilbara Tectonic Zone. The Sholl Shear Zone is a crustal-scale structure that was active during deposition within the superbasin, and represents reactivation of a suture.

The Sholl Shear Zone (Fig. 1) may have provided the pathway for volcanism and related gold mineralization sourced from underlying subduction-modified mantle (Smithies et al. 2004, 2007). At the Mount Oscar prospect, gold-bearing conglomerates (Artemis Resources, 2017b) are interlayered with basalt and are part of the geochemically distinctive Warrambie Basalt of the c. 3010 Ma Whim Creek Group (Smithies et al., 1999; Hickman, 2002; Figs 1, 2). Deposition of the conglomerates and a subsequent 230 million year history of basin formation, volcanism, metamorphism, fluid flow, and folding and faulting were driven by movements on the adjacent shear zone (Hickman, 2016). This may represent one source for gold reworked into conglomerates in the unconformably overlying Fortescue Basin.

Fortescue Basin

The 2775–2630 Ma Fortescue Basin was the subject of a major regional study by Thorne and Trendall (2001). It overlies a craton-wide regional unconformity and represents a rift, deepening to the south. Deposition of the Fortescue Group into this rift began with dominantly subaerial continental flood basalts and associated fluvial and lacustrine sedimentary rocks (Bellary Formation, Mount Roe Basalt, Hardey Formation; Fig. 3). Post-cratonization erosion produced a rugged landscape with up to 500 m of relief (Fig. 4). Small, high-grade, lenticular, gold-bearing conglomerates are present at the basal Fortescue Group unconformity as poorly sorted, channel-fill deposits such as at the Just-in-Time gold mine near

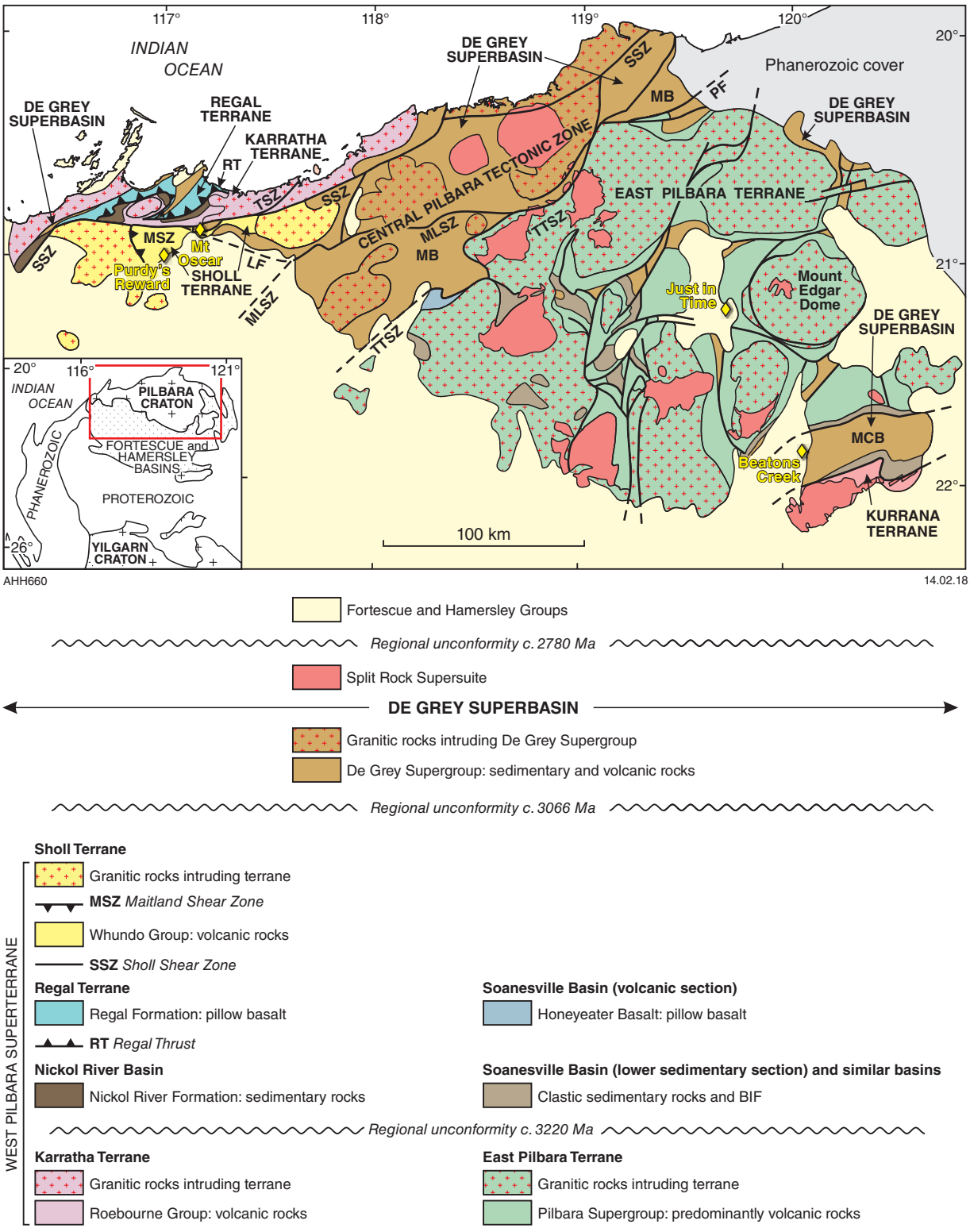

Figure 1. Major tectonic units of the northern Pilbara Craton (after Hickman 2016). Abbreviations: LF, Loudens Fault; MB, Mallina Basin; MCB, Mosquito Creek Basin; MLSZ, Mallina Shear Zone; MSZ, Maitland Shear Zone; PF, Pardoo Fault (part of TTSZ); SSZ, Sholl Shear Zone; TSZ, Terenar Shear Zone; TTSZ, Tabba Tabba Shear Zone

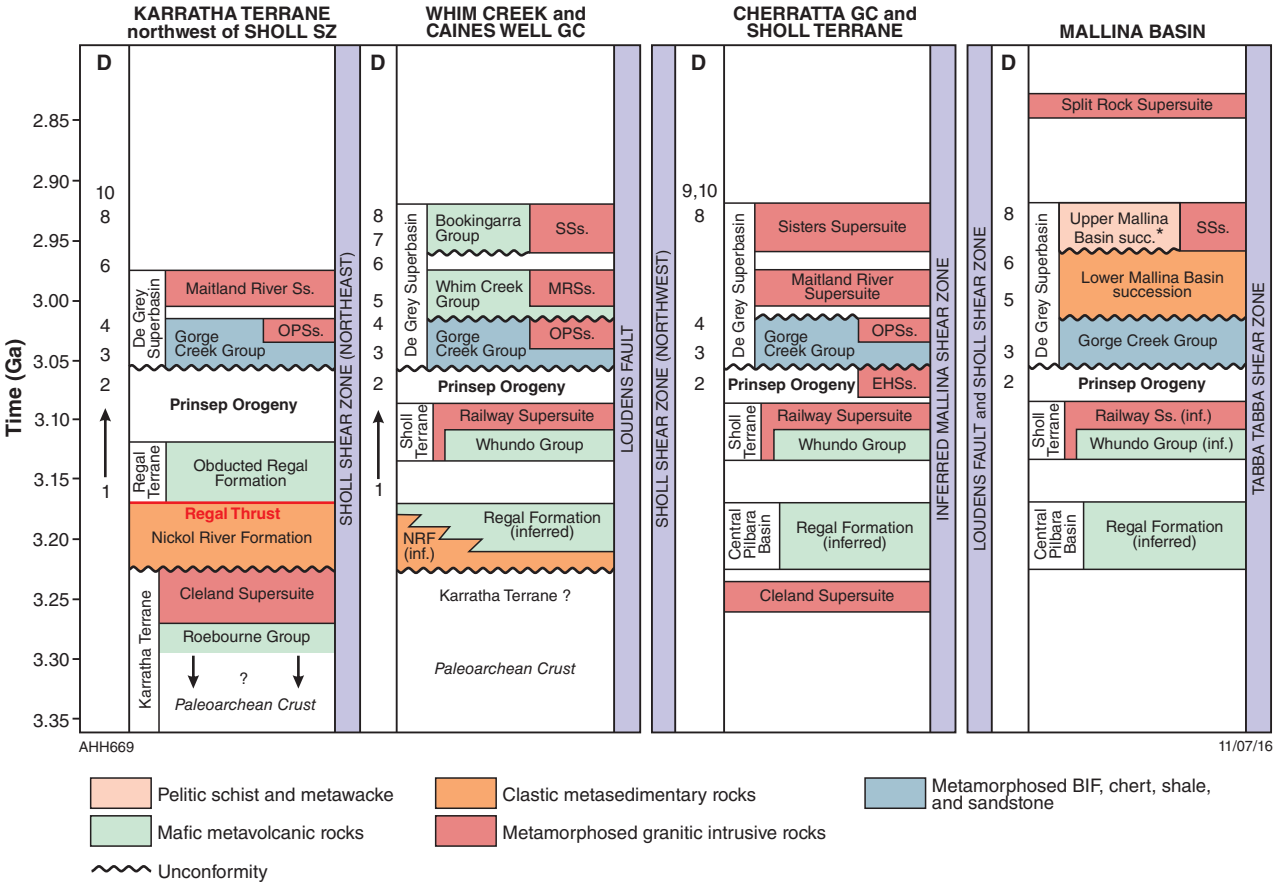

Figure 2. Time–space plot summarizing the stratigraphy and structural history of the four major fault-bounded terranes and basins of the northwest Pilbara Craton (from Hickman, 2016). Differences indicate significant strike-slip displacements along the major faults and regional variability of granitic intrusion, volcanism, and sedimentation following the Prinsep Orogeny (i.e. within the De Grey Superbasin). Abbreviations: GC, Granitic Complex; Ss, Supersuite; EHSs, Elizabeth Hill Supersuite; OPSs, Orpheus Supersuite; MRSs, Maitland River Supersuite; SSs, Sisters Supersuite; D, deformation event; SZ, shear zone (* = succession)

Marble Bar (Fig. 1). In the 1980s CRA drilled eight deep holes through the Fortescue Group testing a Witwatersrand model. These cores are held in the GSWA core library.

Discussion

The Witwatersrand Basin includes the 3086–3074 Ma Dominion Group, with the disconformably overlying Witwatersrand Supergroup comprising the lower 2970–2914 Ma West Rand Group and the upper 2894–2780 Ma Central Rand Group (Fig. 5; Robb and Meyer, 1995; de Kock, 2012; Tucker et al., 2016). Although the De Grey Superbasin in the Pilbara is a time equivalent of the lower part of the Witwatersrand Basin, there appears to be little direct correlation between the two, possibly reflecting different geodynamic histories and tectonic settings. There is no equivalent of the Prinsep Orogeny in the Kaapvaal Craton, and no equivalent of the Gorge Creek or Whim Creek Basins. The West Rand Group may be the time equivalent of the Mallina Basin but there appears to be no equivalent in the Pilbara Craton of the Central Rand Group, which contains the vast majority of the gold deposits in the Witswatersrand Basin.

The base of the Fortescue Group and the base of the Klipriviersberg Group (Ventersdorp Supergroup) both occur at a post-cratonization unconformity at a similar time (c. 2780 Ma; Wingate, 1998; de Kock, 2009, 2012), compatible with the idea of the Vaalbara continent and with the potential for the continuation of the Ventersdorp Contact Reef onto the Pilbara Craton. But, again, the sedimentary environments appear to represent different settings and there is no evidence as yet that the conglomerate-hosted gold deposits at the base of the Fortescue Basin on the Pilbara are anything other than localized channel-fill deposits.

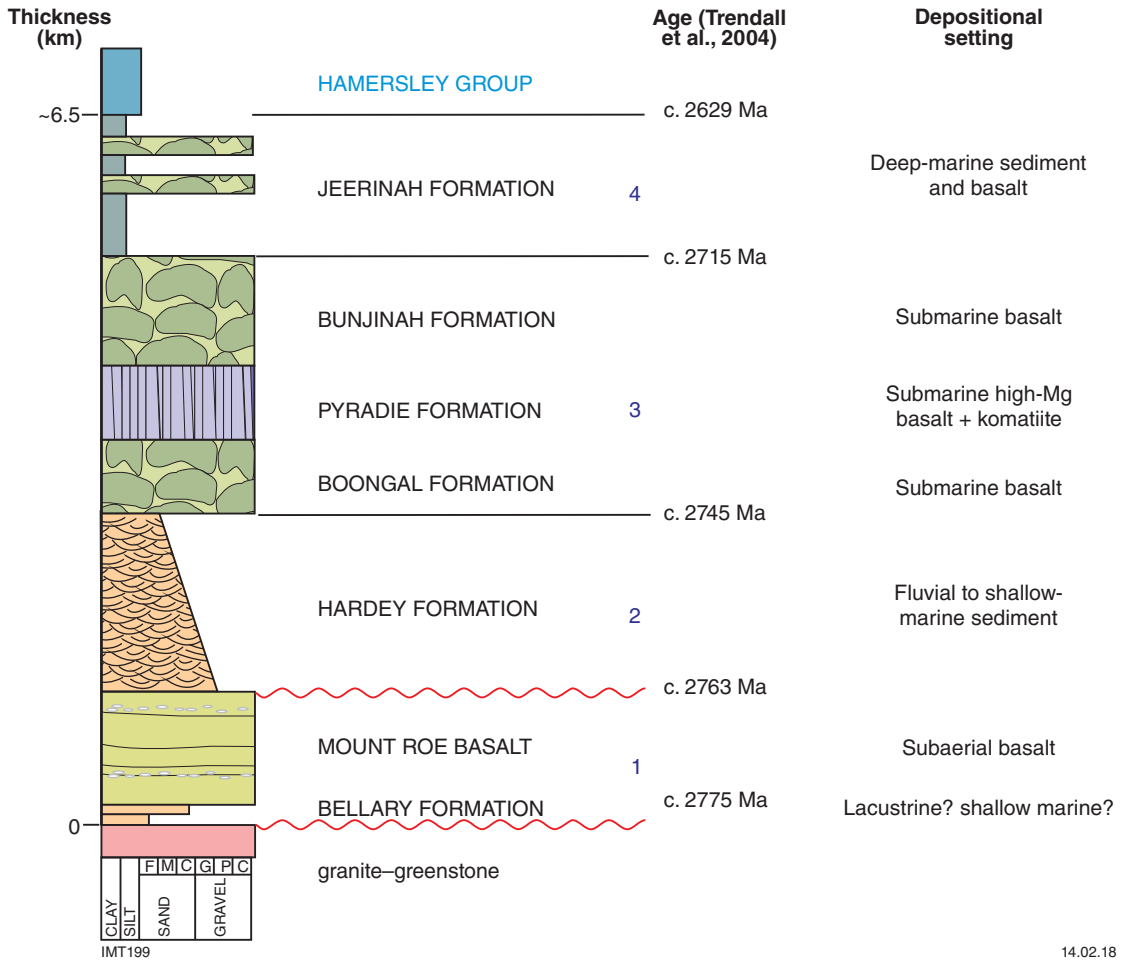

Figure 3. Stratigraphy of southern Fortescue Group (from Thorne et al., 2011)

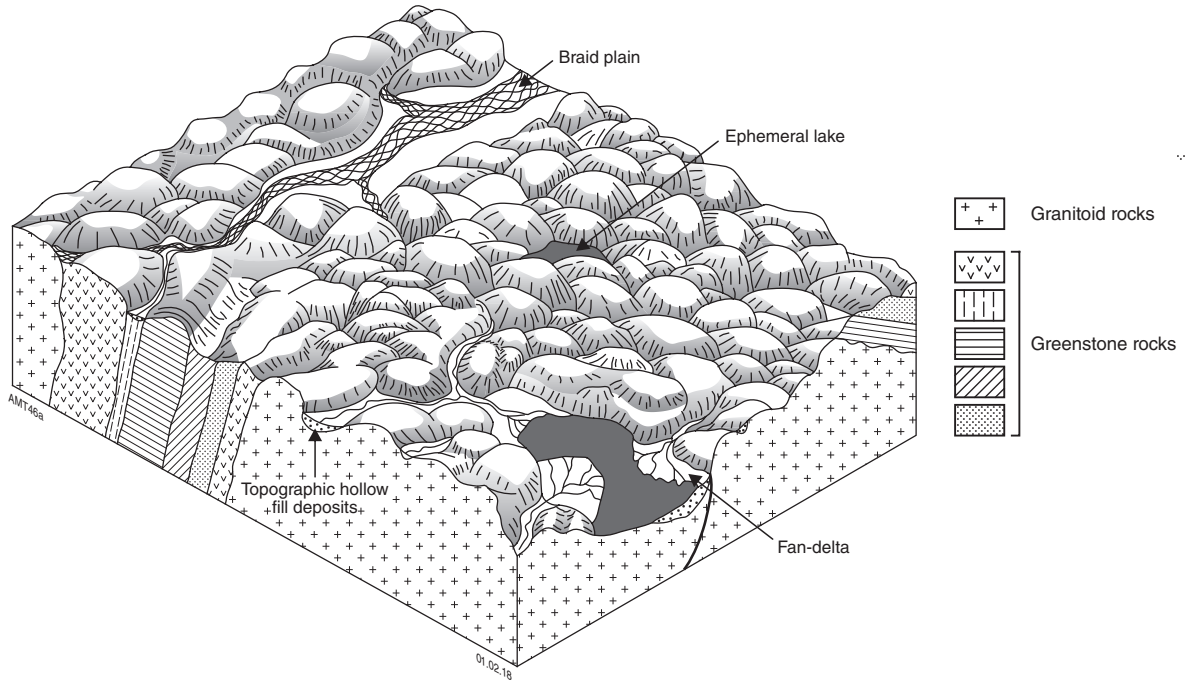

Figure 4. Depositional model for the pre-Mount Roe Basalt sedimentary units of the Fortescue Group (from Thorne and Trendall, 2001)

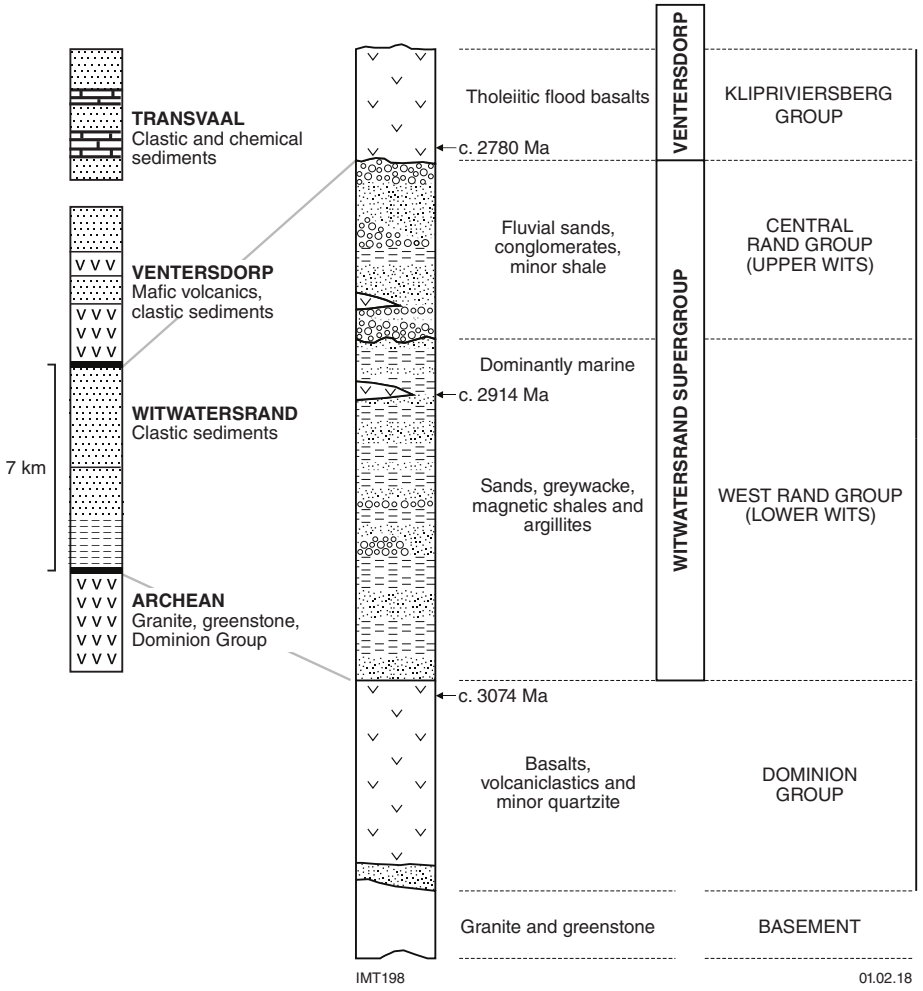

Figure 5. Stratigraphy of the Witwatersrand Basin (modified from Phillips and Powell, 2015)

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