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Palaeomagnetism of Neoproterozoic Sedimentary Successions - the Key to Precambrian Palaeogeography

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Understanding of past continental configurations has advanced by extending our knowledge backwards through time, from the present day arrangement of continents, through the Phanerozoic (540 Ma and younger) supercontinents of Pangaea and Gondwana, to the late Mesoproterozoic to mid-Neoproterozoic (˜1100 - 750 Ma) supercontinent of Rodinia. Although the evolution of Gondwana is relatively well established, the exact configuration of the earlier supercontinent Rodinia, and its assembly and breakup histories, are still widely debated. Our understanding of Rodinia and earlier times is severely hampered by our poor knowledge of paleogeography in the late Neoproterozoic (750 - 540 Ma), the interval during which Rodinia broke apart and Gondwana was formed. This critical gap in our knowledge results mainly from ambiguities and large apparent contradictions in late Neoproterozoic paleomagnetic data. Gaps in palaeomagnetic record lead to problems of longitudinal uncertainty and polarity ambiguity. The latter is of particular importance, because even high-quality results can be used to support remarkably different paleogeographic models by choosing alternative polarity options. Thus, for late Mesoproterozoic and Neoproterozoic time, there are at least four alternative Australia-Laurentia reconstructions, at least six proposed positions of Siberia, and several for Baltica, Kalahari, Amazonia, and Congo. The proliferation of alternative models will continue until the problems of late Neoproterozoic paleomagnetic data are resolved. Australia, Laurentia, Siberia, and Baltica supply the bulk of the palaeomagnetic information for the late Neoproterozoic. Many Precambrian paleomagnetic results are from intrusions or lava flows that cooled quickly, or from limited outcrops of sedimentary strata, and so represent relatively short time intervals. Evidence of rapid tectonic movements, or of large-scale IITPW, may not be available from such discontinuous records. Recent studies of Neoproterozoic sedimentary successions in outcrops and deep drill holes from Australia, Baltica, Siberia,

Greenland, and Svalbard provide new light on those yet unresolved problems. In particular, those studies support low latitude position of major continents during at least some of the Neoproterozoic glaciations. Drill cores provide more complete sedimentary records, particularly in Australia, and are not subject to remagnetisations caused by weathering or lightning strikes. The inability to orient most drill cores accurately, however, has previously made them unpopular subjects for palaeomagnetic study, because non-oriented core samples yield only inclination (palaeolatitude) information. However, the usage of deep-meter log and/or acoustic scanner for the core orientation applied recently to the palaeomagnetic studies of Neoproterozoic drill holes in Australia helps to overcome this obstacle.