Geophysical Research Abstracts
Vol. 15, EGU2013-11397, 2013
EGU General Assembly 2013

Evidence for a dynamic 'Snowball Earth' in Neoproterozoic Svalbard through magnetic, structural and sedimentological analysis

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In recent years, our understanding of glacial sedimentation has improved through observations of current glacial environments,aided by the development of new techniques. Anisotropy of magnetic susceptibility (AMS) has been shown to provide insights into till formation and deformation. This technique, along with field, structural and sedimentological analysis has been applied to the Neoproterozoic Wilsonbreen Formation in Svalbard. Fabrics within sediments normally result from processes acting on the sediment either during or shortly after deposition. Fabrics can therefore be used to provide information on genetic environment, palaeo-ice flow directions in sub-glacially generated or deformed sediments and palaeo-slope in mass flow units. Primary fabrics (not subsequent tectonic fabrics) are confirmed through comparison of AMS with pebble. Both sets of data reveal almost identical fabric orientations suggesting that AMS does indeed record primary fabrics and that these fabrics indicate flow initially north-south but switching to northwest – southeast upwards in the succession. Through analysis of AMS, sedimentology and structures at both macro and microscopic scales, a range of glacial-depositional environments (subglacial, glaciomarine and proglacial) as well as non-glacial (terrestrial, lacustrine and fluvial) are recognised, which are highly variable both spatially and temporally. Glacial cycles are observed, some which appear analogous to processes occurring in modern glacial environments. The range of facies seen and the possible cyclicity in some of the deposition reveal that in contrast to a single advance meltback cycle, the Wilsonbreen is composed of a series of oscillations where glaciers advanced and retreated. This variability could possible provide challenges to the classic 'Snowball Earth' model.