# PRECAMBRIAN SUPERCONTINENTS – CURRENT STATUS AND REMAINING QUESTIONS

Lauri J. Pesonen and Toni Veikkolainen
Invited talk

Solid Earth Geophysics Laboratory, Department of Physics,
University of Helsinki, Finland, FI-00014 Helsinki, Finland

We show the main Precambrian supercontinents, review their databases and discuss their importance for understanding the geological evolution of the Earth. We also analyze the geometries of these supercontinents. Derived from all these we assess three problematic observations that await solutions.

**Keywords:** Precambrian, Supercontinents, Paleomagnetism, Kenorland, Nuna, Columbia, Rodinia

The importance of supercontinents in understanding of the geological evolution of the Earth has been recently widely discussed. Geological processes linked to the supercontinent formation include matching of orogenic belts or rifts (break-ups), mantle superplumes with large igneous provinces (LIPs), radiating and suddenly fragmenting huge dyke swarms showing peaked age distributions, sporadic kimberlite bursts, low latitude glaciations, carbon isotope excursions, etc. Three Precambrian supercontinents Kenorland (2700-2400 Ma; Fig.1a), Nuna/Columbia (1850-1200 Ma; Fig.1c) and Rodinia (1050-750 Ma; Fig.1b) existed during the Precambrian. Based on geological grounds, a "boomerang"-shaped assembly called "SAMBA" and consisting of Laurentia, Baltica and Amazonia (and perhaps Siberia, North China and India; Fig.1d), has recently gained considerable attention since it provides a testable scenario not only for paleomagnetism but also for understanding the linear geological age belts with economically valuable ore formations (Johansson 2009; Pesonen *et al*. 2012). However, the background and databases behind SAMBA and other Precambrian continent assemblies are heavily debated due to scarcity of reliable paleomagnetic data or lack of precise isotopic ages. In this paper we review the paleomagnetic databases behind the Precambrian supercontinents (Veikkolainen *et al*. 2014). In the first part we show that based on global analysis using five techniques, the geomagnetic field during most of the Precambrian time (notably during Archean, Paleoproterozoic and Neoproterozoic times) was that of the geocentric axial dipole (GAD). Perhaps, during the Mesoproterozoic (Nuna) the field may have been contaminated by small axial multipole terms less than ten degrees. These, if real, may produce errors to the continental reconstructions less than the error (*ca*. 10o) of the paleomagnetic latitude determination (Veikkolainen 2014; Pesonen et al. 2012).

In the second part we discuss geometries of supercontinents. The Archean-Paleoproterozoic Kenorland and the Neoproterozoic Rodinia appear to lie at high to mid latitudes while the Mid-Proterozoic Nuna (and also SAMBA) appears to lie at shallow (equatorial) latitudes. This observation could be the simple explanation to the apparent departure of the field from GAD model. The sedimentological indicators of paleoclimate are generally consistent with the paleomagnetic latitudes, with the exception of the Early Proterozoic, when low latitude glaciations took place on several continents. The Proterozoic continental configurations are generally in agreement with geological models of the evolution of the continents. It is noteworthy that the geometries as well as latitudinal spreading of Kenorland, Nuna and Rodinia depart from each other and also from the subsequent supercontinent Pangaea. The tectonic styles of their amalgamations are also different, reflecting in changes of size and thicknesses of the cratonic blocks as well as changes in the thermal conditions of the mantle throughout time.

Three problematic observations await solutions. 1. During Ediacaran (*ca*. 615-560 Ma) huge rapid jumps appear to have take place in the APWPs of major continents like Laurentia, Baltica and Australia. It is unclear whether they represent true polar wander (TPW), rapid continental drift, or superposition of two magnetization vectors (steep, shallow) in the studied rocks. 2. During the Late Precambrian (1115-1108 Ma) the majority of the continents seem to have drifted very rapidly, almost exceeding the plate velocity speed limit (25 cm/yr), as based on the APWPs. Do these rapid APWs represent a true latitudinal drift of the cratons, TPW or are they caused by multi-pole field? 3. Why the ca. 1900-1800 Ma orogenic belts, which probably represent accretional type of amalgamations of juvenile blocks onto Laurentia, Baltica and Amazonia are oblique unlike the younger Late Precambrian Grenville collisional belts which merely border the continental fragments? (Fig.1)

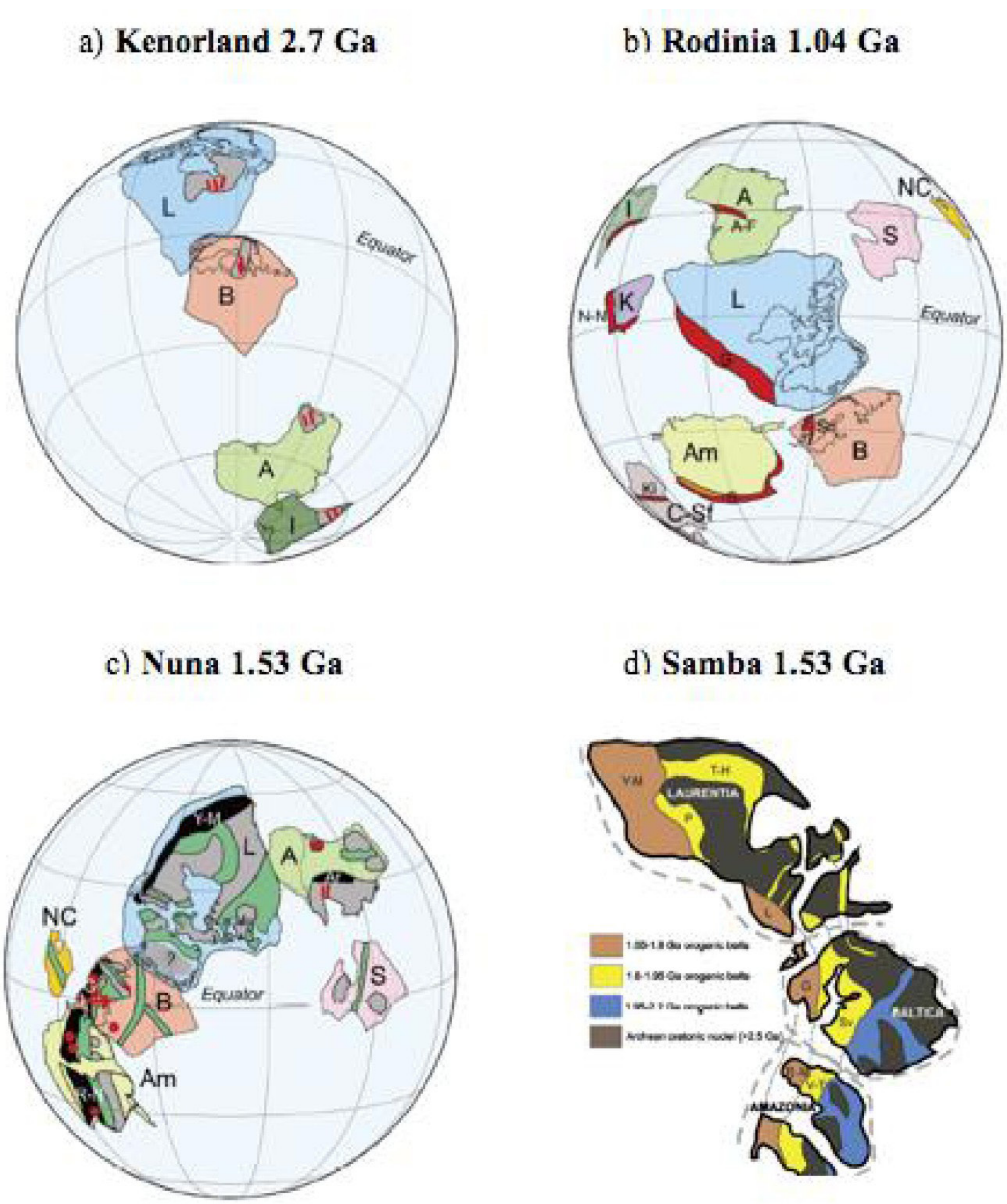


**Figure 1.** Precambrian Continents: a) Kenorland; b) Rodinia; c) Nuna/Columbia; d) Samba

## References

Johansson, Å., 2009. Baltica, Amazonia and the SAMBA connection -1000 million years of neighborhood during the Proterozoic? *Prec. Res.*, 175, 221–234.

Pesonen, L.J., Mertanen, S., Veikkolainen, T., 2012. Paleo-Mesoproterozoic Supercontinents – A Paleomagnetic View. *Geophysica, 48*, 5-47.

Veikkolainen, T., 2014. Database-wide studies on the validity of the geocentric axial dipole hypothesis in the Precambrian. Report Series in Geophysics No.75 (PhD dissertation), University of Helsinki, Helsinki, Finland, 61 pp. + five articles.

Veikkolainen, T., Pesonen, L.J., Evans, D.A.D., 2014. PALEOMAGIA - A PHP/MYSQL database of Precambrian paleomagnetic data. *Stud. Geophys. Geod., 58*, 425-441.