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Palaeomagnetic Databases: 4 th Nordic Palaeomagnetic Workshop

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As a continuation of previous Nordic Palaeomagnetic Data Base Meetings, a week-long Palaeomagnetic Workshop, the 4th in number, was held near Aarhus (Denmark) from 29th October to 6th November 1999. As the previous ones the workshop was situated in a small village to provide an atmosphere were synergetic benefits could be fruitfully absorbed. In connection with the Workshop a one-day Palaeomagnetic Symposium was also arranged at Aarhus University (Abrahamsen 1999).

The idea behind the Nordic Palaeomagnetic Workshops is to bring together every 4 years most Nordic scientists active within palaeomagnetic research, and to invite outstanding foreign colleagues to join the workshop, with the purpose to (1) update or create palaeomagnetic database information for specific areas, time intervals and purposes, (2) to use these data by the synergetic effects of a working group for continental reconstructions, and (3) to publish the results obtained (e.g. Elming et al. 1993, Torsvik et al. 1992, 1996; for publications of these workshops see Abrahamsen & Pesonen 1999).

Previous workshops were successfully held in Espoo in Finland (1986), Luleå in Sweden (1990) and Trondheim in Norway (1994) all of which resulted in updating of palaeomagnetic databases and inspired collegial collaboration. Further details are given in Pesonen (1987, 1999) and Pesonen & Van der Voo (1991).

The focus and the topics for this workshop were

1) to update the palaeomagnetic databases of each continent and their tectonic building blocks from Archean to the present with a particular emphasis put upon checking the data reliability and in addressing a quality factor for each entry (Van der Voo 1993),
2) to include the most recent isotopic and biostratigraphic age-determinations for each result. The updated data were used to model continental reconstructions for selected time intervals such as 2.5 Ga, 1.8 Ga, 1.3 – 1.0 Ga, and for the Phanerozoic times (one of the tasks of the workshop was also to test the proposed supercontinent assemblies, e.g. Rodinia (Dalziel 1999), as based upon the best quality palaeomagnetic data),
3) to evaluate palaeomagnetic and other relevant evidence for low-latitude glaciations (Schmidt & Williams 1995, Hoffman et al. 1998),
4) to consider non-dipole aspects of the geomagnetic field.

The three Workshop-groups established and their coordinators were (A) Pre-1 Ga compilations and reconstructions (Lauri Pesonen), (B) Post-1 Ga compilations and reconstructions (Trond Torsvik), and (C) Palaeo-Climate & Tillites (Niels Abrahamsen).

In the workshop (and the one-day symposium) 7 invited and 11 Nordic colleagues participated. The invited specialists were Ian Dalziel (Austin, USA), Rob Van der Voo (Ann Arbor, USA), Manoel S. D'Agrella-Filho (Sao Paolo, Brazil), Joseph Meert (Terre Haute, USA), Marek Lewandowski (Warszawa, Poland), Sergei Pisarevski (Perth, Australia), Phillip Schmidt (Sydney, Australia). The Nordic colleagues were Satu Mertanen and Lauri Pesonen (Finland), Sten-Åke Elming, Göran Bylund and Håkan Mattsson (Sweden), Trond Torsvik, Harald Walderhaug and Erik Halvorsen (Norway), Anne Schmidt, Mads F. Knudsen and the host Niels Abrahamsen (Denmark).

The success of the workshop was considerably enhanced by the availability of several computers linked to the Internet, giving access to the GPMDB (Global Palaeomagnetic Data Base, McElhinny & Lock 1995), and the updated Millenium version 2000 of the GMAP program of Torsvik and Smethurst (1999), enabling the participants to extract and plot relevant palaeomagnetic data, to spline the APWPs (Apparent Polar Wander Paths) for these data, and finally to rotate the individual continents or cratons around the respective Euler-poles, resulting in global palaeogeographical reconstructions of the continents (and supercontinents) at various time slots.

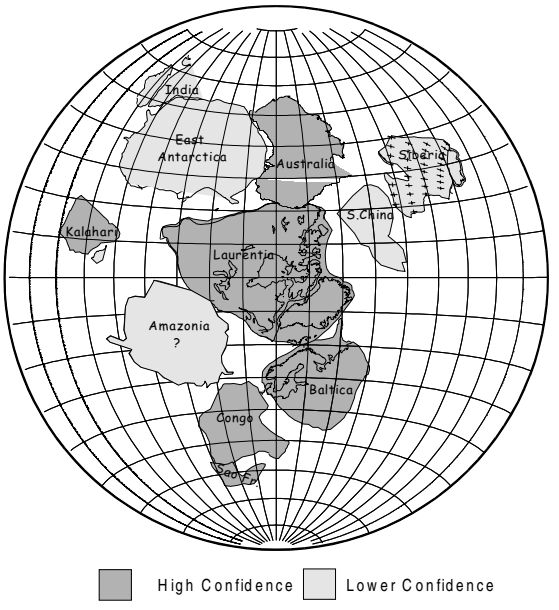

Fig. 1. Reconstruction of the beginning of the Rodinia superpontinent at ca. 1050 Ma, based on palaeomagnetic data. The continents involved are Laurentia, Baltica, Australia, Kalahari, Congo and Sao Francisco (dark: higher confidence) and Siberia, S. China, East Antarctica, India, Madagascar and Amazonia (light: lower confidence), the latitudinal positions and orientations being based on available best palaeomagnetic data.

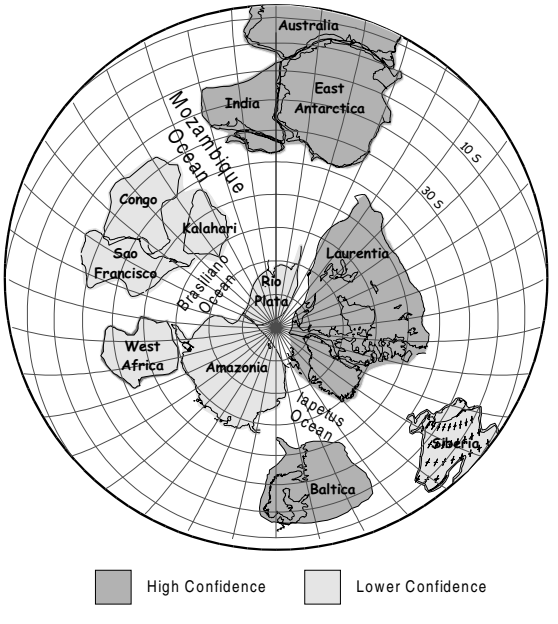

Fig. 2. Late Precambrian assemblage of the continents around 580 Ma, as based upon a critical assessment of available palaeomagnetic data (dark: higher confidence; light: lower confidence).

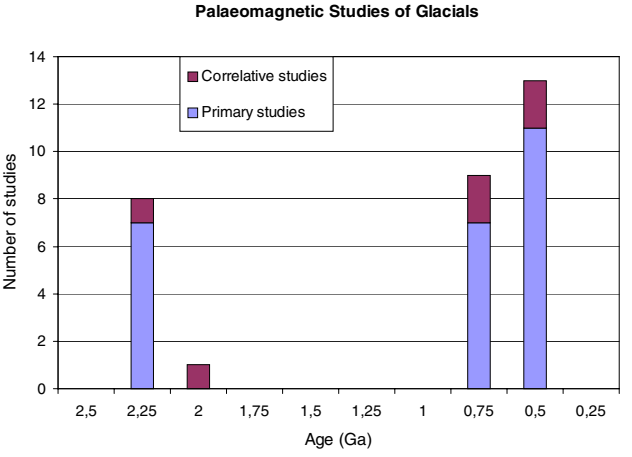

Fig. 3. Number of palaeomagnetic studies of the three periods of major Proterozoic glaciations (extracted from the GPMDB).

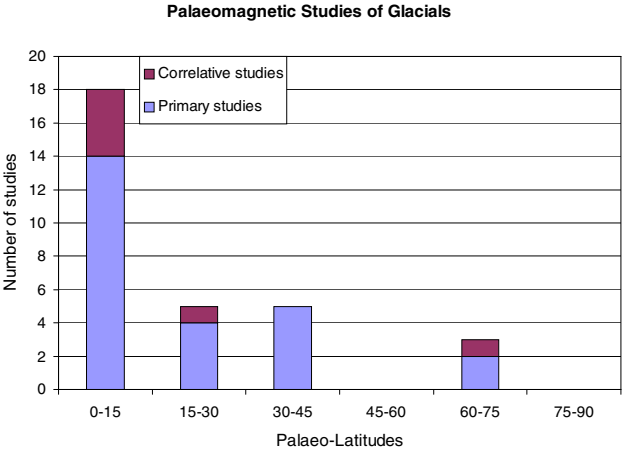

Fig. 4. Palaeomagnetically determined palaeolatitudes of the three periods of major Proterozoic glaciations (extracted from the GPMDB).

The Pre-1 Ga group succeeded in producing a series of continental assemblies at six geological times in the Precambrian (2.45 Ga, 2.0 Ga, 1.8 Ga, 1.6 Ga, 1.25 Ga, and 1.05 Ga, respectively), as illustrated in the example (Fig. 1) for the beginning of the Rodinia supercontinent configuration at ca. 1050 Ma. These reconstructions were based solely on (a priori) palaeomagnetic data. They were then compared with geologically based reconstructions previously proposed.

The Post-1 Ga group also succeeded in producing a series of detailed palaeogeographical maps of the continents, configured in Late-Precambrian to Early Palaeozoic assemblages, as illustrated with the example of the 580 Ma reconstruction (Fig. 2).

The Palaeo-Climate & Tillite Group focussed on the low-latitude glaciations, also known as the "Snowball Earth" problem. The palaeomagnetic data for

tillites themselves available so far are very limited in number, but nevertheless there is a significant number of low-latitude Proterozoic data for rocks on the Earth of about the same age as the tillites and tilloid sediments, which are dated in the time-windows of ca. 600 Ma (Vendian), ca. 700 Ma (Sturtian) and ca. 2,300 Ma (Huronian), respectively (Figs. 3 & 4).

It was realised that a powerful modern database on this topic is urgently needed. In order to fully understand the low-latitude tillite occurrences on continents (e.g. Canada, Australia, Baltica, etc.) the Tillite Working Group therefore created the nucleus for such a new database in Access, equivalent to the GPMDB, in which the many variables related to the palaeoclimate problems associated with the palaeomagnetic shallow inclinations (and hence low palaeolatitudes?) will be compiled in the time to come.

Variables such as sea level heights, carbon and oxygen isotopes, $^{87}Sr/^{86}Sr$-data, information on paleogeography of the continents and supercontinents etc. are relevant as well. Off course this job could not be brought to an end during only 8 days of the workshop, the climatic and geological (including isotope) input being much more abundant than that of the palaeomagnetic results so far published. Resulting papers from the subjects of the three working groups are expected to appear in the near future.

Acknowledgements

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Dansk Sammendrag

Omkring hvert fjerde år arrangeres der af den Nordiske Palæomagnetiske Arbejdsgruppe en ugelang palæomagnetisk workshop på skift i et af de Nordiske lande. Formålet med disse workshops er, sammen med fremstående internationale kolleger, at opdatere og videreudvikle palæomagnetiske databaser og vurdere disses anvendelser i forbindelse med globale palæogeografiske rekonstruktioner.

Den seneste palæomagnetiske workshop blev afholdt i Rønde ved Aarhus i november 1999, og i sammenhæng hermed blev et palæomagnetisk symposium arrangeret ved Geologisk Institut, Aarhus Universitet (Abrahamsen 1999).

I workshop'en arbejdede man med at opdatere de palæomagnetiske databaser for hvert kontinent (lithosfæreplade), vurdere deres fragmentariske opbygning siden Arkæisk tid, kontrollere datakvaliteten, inkludere de seneste isotopdateringer, og derved producere kontinentale rekonstruktioner for aldrene 2.5 Ga, 1.8 Ga, 1.3 B 1.0 Ga, hvorved forskellige foreslåede konfigurationer for superkontinentet Rodinia baseret alene på palæomagnetiske data kunne testes (eksempler er vist i Figur 1 og 2).

Desuden blev palæomagnetiske data i forbindelse med vidnesbyrd om glaciationer ved lave breddegrader sammenstillet og evalueret for at teste hypotesen om Jorden som en »snebold«. Grupperingen af hidtil publicerede relevante palæomagnetiske data er vist i Figur 3 og 4. Endelig blev non-dipol aspekter for det geomagnetiske felt diskuteret, idet afvigelser fra et dipolfelt har afgørende betydning for nøjagtigheden af vore pladetektoniske rekonstruktioner ud fra de palæomagnetiske data.

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