LGM reached the present level ca. 7000 ybp. There is compelling evidence to show that the sea has transgressed into the continental depressions referred above for brief period and regressed to the present level ca. 4000 ybp leaving behind a vast lagoon. The largest of the lagoons along the west coast of India, namely, the Vembanad Lagoon is but a surviving remnant of this vast lagoonal water body. There is good evidence to indicate that a period aridity has prevailed here ca. 3000 ybp. This period of aridity is represented by a red clay or sand horizon. Whereas the lagoonal stage is marked by black clay with frequent admixture of molluscan shells the following regression is marked by a topography characterized by ridges and swales. There is some evidence to believe that there existed a spell of sedimentation in lacustrine and other continental environments during pre-LGM times. This aspect has not been systematically investigated. It is pointed out that the present landscape of the coastal region and the hinterland is directly related to Quaternary geological, tectonic and climatic events. This is the foundation for all the environmental and ecological factors. Any attempt at protecting the environment calls for the awareness about this. The present study, which is still in progress, is an effort in creating this awareness on a scientific basis. Besides the environment, the Quaternary events have given rise to important resources, the most important of which is the surface unconfined aquifers, which yield fresh water to thousands of households.

Mesoproterozoic to Palaeozoic Evolution of Eastern Svalbard and Barentsia

Åke Johansson[1], Alexander Larionov[1], Yoshihide Ohta[2] and Alexander Tebenkov[3]

[1] *Swedish Museum of Natural History, Box 50 007, S-104 05 Stockholm, Sweden, E-mail: ake.johansson@nrm.se*

[2] *Norwegian Polar Research Institute, C/o NGU, Box 5348, N-0304 Oslo, Norway*

[3] *Polar Marine Geological Research Expedition, Pobeda Street 24, Lomonosov 189 510, Russia*

Svalbard is located in the northwest corner of the Barents Sea Shelf and the Eurasian Plate, in a key area for restoring Caledonian and older orogenes in the North Atlantic and Arctic regions. Svalbard was assembled from at least three different terranes during the Caledonian orogeny (e.g., Harland, 1972, 1997), referred to as the Southwestern, Northwestern and Eastern Terranes by Gee (1986), separated by large-scale transcurrent faults (Fig. 1). The Eastern Terrane may be further subdivided into a West Ny Friesland Terrane and a Nordaustlandet Terrane (Witt-Nilsson, 1998). The Nordaustlandet Terrane is the only exposed part of the Barentsia microcontinent, which continues under the Barents Sea to the south and east (Gee and Ziegler, 1996).

The bedrock of Nordaustlandet essentially consists of a Caledonian basement, overlain by Carboniferous and younger platform sediments. The basement in turn consists of a Grenville-age complex, overlain by Neoproterozoic and Cambrian-Ordovician sediments, and intruded by Caledonian granites. The oldest exposed unit is the Mesoproterozoic Brennevinsfjorden Group, consisting of partly turbiditic metasediments. This is unconformably overlain by rhyolitic to andesitic volcanics of the Kapp Hansteen Group, dated to ca. 960 Ma by U-Pb, and

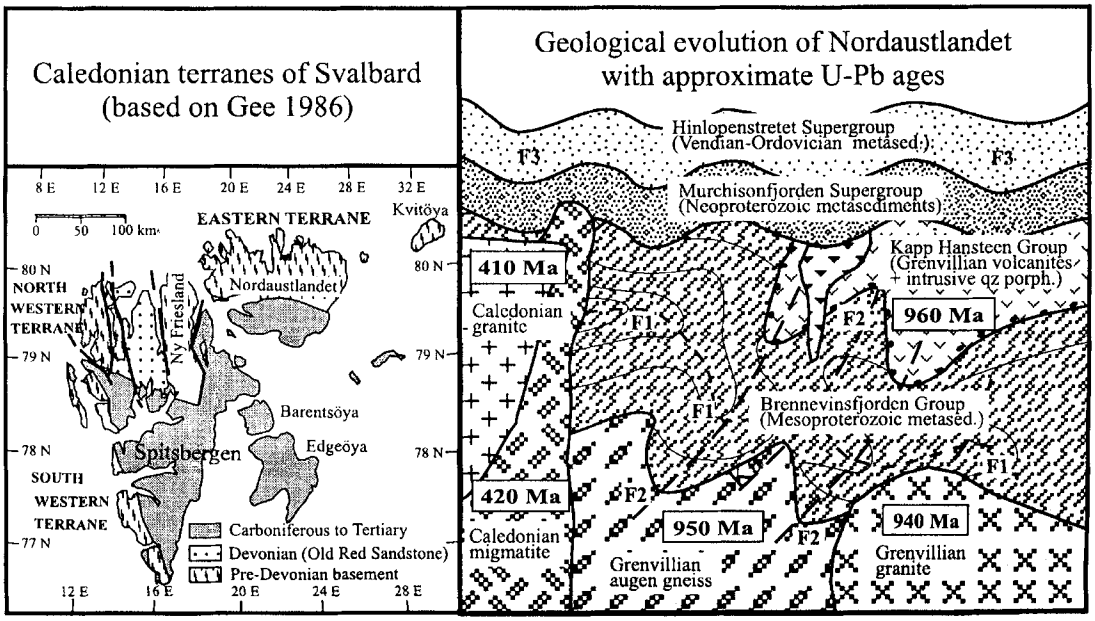

Fig. 1. The Caledonian terranes of Svalbard and the geological evolution of Nordaustlandet.

intruded by crustal anatectic granites, partly converted to augen gneisses, dated to 960-940 Ma (Gee et al., 1995; Johansson et al., 2000). The geochemistry suggests formation in a volcanic arc to syn-collisional tectonic setting (Ohta, 1985; Johansson et al., 2000). These rocks acted as basement for the deposition of the Neoproterozoic Murchisonfjorden Supergroup and Vendian-Ordovician Hinlopenstretet Supergroup (see references in Harland, 1997). Caledonian folding, metamorphism and migmatization was accompanied by intrusion of another set of crustal anatectic granites, dated by U-Pb to 440-410 Ma (Gee et al., 1999).

To judge from the Nordaustlandet data, the Barentsia microcontinent thus consists of a late Grenvillian complex, extensively modified by Caledonian tectonothermal activity. The evolution of eastern Svalbard may be readily correlated with that of the East Greenland Caledonides, and most reconstructions place eastern Svalbard off the east coast of central east Greenland prior to Caledonian orogeny (cf. Harland, 1972, 1997; Gee and Page, 1994; Condie and Rosen, 1994). It would thus have formed part of a branch of the Grenville belt trending north (in present-day coordinates) between Greenland and Scandinavia (where North China is located in the Rodinia reconstruction on the IGCP 440 poster). Alternatively, eastern Svalbard may have been located further to the north, closer to its post-Caledonian position off the north coast of Greenland. In that scenario, Barentsia may have been part of an extensive Grenvillian terrane encompassing the Pearya Terrane of northern Ellesmere Island in the Canadian Arctic (cf. Trettin, 1987; Ohta et al., 1989; Ohta, 1994) and possibly other dispersed circum-Arctic terranes like Taimyr (cf. Pease and Gee, 2000). In either case, Barentsia became assembled to Rodinia during a late stage of the Grenvillian orogeny, at around 950 Ma, while other parts of Rodinia may already have started to break up.

References

Condie, K.C. and Rosen, O.M. (1994) Laurentia-Siberia connection revisited. Geology, v. 22, pp. 168-170.

Gee, D.G. (1986) Svalbard's Caledonian terranes reviewed. Geologiska Föreningens i Stockholm Förhandlingar, v. 108, pp. 284-286.

Gee, D.G. and Page, L.M. (1994) Caledonian terrane assembly on Svalbard: new evidence from $^{40}Ar/^{39}Ar$ dating in Ny Friesland. Amer. J. Sci., v. 294, pp. 1166-1186.

Gee, D.G., Johansson, Å., Ohta, Y., Tebenkov, A.M., Krasil'scikov, A.A., Balashov, Yu.A., Larionov, A.N., Gannibal, L.F. and Ryungenen, G.F. (1995) Grenvillian basement and a major unconformity within the Caledonides of Nordaustlandet, Svalbard. Precamb. Res., v. 70, pp. 215-234.

Gee, D.G. and Ziegler, P.A. (1996) TIMPEBAR - Basement control on basin evolution. In: Gee, D.G. and Zeyen, H.J. (Eds.), EUROPROBE 1996 - Lithosphere Dynamics: Origin and Evolution of Continents. EUROPROBE Secretatriat, Uppsala University, pp. 101-109.

Gee, D.G., Johansson, Å., Larionov, A.N. and Tebenkov, A.M. (1999) A Caledonian granitoid pluton at Djupkilsodden, central Nordaustlandet, Svalbard: age, magnetic signature and tectonic significance. Polarforschung, v. 66, pp. 19-32.

Harland, W.B. (1972) Early Palaeozoic faults as margins of Arctic plates in Svalbard. Proceedings of the 24th International Geological Congress, Montreal, v. 3, pp. 230-237.

Harland, W.B. (1997) The Geology of Svalbard. The Geol. Soc. London, Mem. No.17, 521p.

Johansson, Å., Larionov, A.N., Tebenkov, A.M., Gee, D.G., Whitehouse, M.J. and Vestin, J. (2000) Grenvillian magmatism of western and central Nordaustlandet, northeastern Svalbard. Trans. Royal Soc. Edinburgh. Earth Sci., v. 90, pp. 221-254.

Ohta, Y. (1985) Geochemistry of the late Proterozoic Kapp Hansteen igneous rocks of Nordaustlandet, Svalbard. Polar Res., v. 3, pp. 69-92.

Ohta, Y. (1994) Caledonian and Precambrian history in Svalbard: a review, and an implication of escape tectonics. Tectonophys., v. 231, pp. 183-194.

Ohta, Y., Dallmeyer, R.D. and Peucat, J.J. (1989) Caledonian terranes in Svalbard. Geol. Soc. Amer. Spl. Paper, No. 230, pp. 1-15.

Pease, V. and Gee, D.G. (2000) A Neoproterozoic connection between Baltica and Siberia. Abstract, 31st. International Geological Congress, Rio de Janeiro (on CD-ROM).

Trettin, H.P. (1987) Pearya: a composite terrane with Caledonian affinities in northern Ellesmere Island. Canadian J. Earth Sci., v. 24, pp. 224-245.

Witt-Nilsson, P. (1998) The West Ny Friesland Terrane: an exhumed mid-crustal obliquely convergent orogen. Unpub. Ph.D.thesis, Department of Earth Sciences, Uppsala University, 28p.

Preliminary Fluid Inclusion Study of the High-Grade Metamorphic Rocks of the Northern Part of Visakhapatnam, India

T. Joko[1], T. Tsuchiya[2], S. Taguchi[3], H. Matsueda[4], R. Takahashi[2] and S. Srinivas[2]

[1] *The Yomiuri Shimbun, Tokyo, Japan*

[2] *Department of Earth and Planetary Science, Hokkaido University, Sapporo, Japan*

[3] *Department of Earth System Science, Fukuoka University, Fukuoka, Japan*

[4] *Hokkaido University Museum, Sapporo, Japan*

The Eastern Ghats Mobile Belt (EGMB) mainly consists of metamorphosed supracrustals of granulite facies, granites, charnockites-enderbites, anorthosites and alkaline rocks with minor amount of marble and quartzite. In the northern part of Visakhapatnam a large amount of garnet-sillimanite gneiss (khondalite) occupies a large area in the form of a gigantic sheath fold. The sheath fold is named as "Madhuravada Omega Structure" or "Madhuravada Sheath Fold. Thick layers of quartzite are intercalated with khondalites forming the peripheral part of the Madhuravada Sheath Fold. The core of the dome is occupied by quartzo-feldspathic gneiss (leptynite) and small amount of granulites and sapphirine granulites also