Bulletin of the Geological Society of Denmark, Vol. 44, p. 44. Copenhagen, 1997-03-15. https://doi.org/10.37570/bgsd-1998-44-02

Danish Lithosphere Centre – a new face in Danish earth science

STEFAN BERNSTEIN & FLEMMING MENGEL

On February 1, 1994, a new earth science research centre opened in Copenhagen after a two-year stage of intense planning and proposal writing. The Danish Lithosphere Centre (DLC) was one of 24 centres that eventually were funded by the Danish National Research Foundation (Grundforskningsfondet) and was granted DKK 70 mill. for a five-year period. The centre is thus financially independent, but is hosted by the Geological Survey of Denmark and Greenland (GEUS) and the Geological Institute and Museum at the University of Copenhagen (GI and GM). Today (early 1997) DLC has 16 geologists and geophysicists, one of which is appointed director, an administrative department leader, one laboratory technician, 6 Ph. D. students, and 3 guest researchers. The strong bonds to the host institutions are maintained through 14 Research Fellows at GEUS, GI and the Geological Museum. In addition, DLC has a large number of associated international research partners (49), who participate in the field operations and have regular contact with DLC mainly through exchange visits and scientific workshops, of which 4 has now been held at DLC.

DLC's existence beyond the initial period depends on a successful outcome of the review by an international evaluation board during the first half of 1997. If this review is positive, the centre will continue for a new five-year funding period. With the evaluation process is underway, it seems appropriate to present an overview of the main activities and achievements so far.

The initial DLC research proposal focused on two main themes, namely (1) plate collision and orogenic processes in the Precambrian, exemplified by the Palaeoproterozoic Nagssugtoqidian orogen in West Greenland, and (2) formation of volcanic rifted margins, exemplified by the Tertiary continental break-up of Greenland from Europe and subsequent formation of the North Atlantic.

DLC researchers, Research Fellows and international partners have spent two field seasons in West Greenland, each year with 15 or more participants. The orogen itself is mainly composed of Archaean gneisses, variably reworked during the early Proterozoic Nagssugtoqidian orogenic event. It has been possible to identify a pre-Nagssugtoqidian orogenic cycle at ca. 2870-2813 Ma, and in the southern foreland, just south of Søndre Strømfjord airport, an old Archaean crustal block has been found. The ca. 3.5 Ga old Aasivik terrane is among the oldest on Earth. Prior to the main deformational phase, the area was intruded by the 2 Ga old Kangamiut dyke swarm. The age of the dykes preclude an emplacement during an initial rifting stage. Instead they appear to have been emplaced in an overall transpressional stress field, and a back-arc setting has been proposed. In the central part of the orogen, the presence of a calc-alkaline quartz-diorite, Proterozoic sediments and remnants of ultramafic rocks strongly suggests the former presence of an island arc, oceanic crust and a collisional suture. Analysis of the complex structures in that region have identified phases of contraction followed by extension, both occurring in an overall compressional setting. These structures are well known from younger orogens, where higher levels are exposed, but are rarely preserved (or recognised) in ancient orogens. The work has also shown that many of the large scale structures, assumed to be represent significant transcurrent movements during orogenesis, are in fact Archaean in age. Individual segments of the orogen followed very different uplift paths. P-T studies show that the southern margin of the orogen was buried at least 40–45 km, followed by rapid uplift, whereas other sections preserve evidence of very slow uplift (up to 200 m.y. after the thermal peak).

Future research will continue to study this ancient collision orogen, but will also try to draw parallels with younger orogens, e.g. the Alps and the Caledonides, where higher levels are exposed. Also, the sources of early Archaean crust formation will be addressed.

The studies of continental break-up processes in the Tertiary of East Greenland has involved both off-shore and on-shore activities. Two seasons of on-shore field operations, partly aimed at understanding the architecture of the extensive plateau basalt sequences south of Scoresby Sund, and initial compilation of a large photogrammetric survey demonstrates a thickness in excess of 6 km in the coastal part of the lava pile. Since the northern part of the basalt cover has been studied previously, it was a great surprise to find that depleted Mid-ocean ridge type basalts are common in the coastal segments. Geochronological data shows that magmatism presently exposed on-shore started prior to 59 Ma, with a main burst around the time of break-up at 56 Ma. However, widespread basaltic magmatism continued at the margin 5–8 m.y. subsequent to break-up, i.e., well after the first formed oceanic crust had stabilised. The first helium isotope data from the North Atlantic Tertiary province suggests that this late magmatic event reflects the passage of the Icelandic mantle plume under the present-day East Greenland coastline. Detailed structural investigations of the coastal dyke swarm demonstrate intense crustal deformation prior to main volcanic episodes, and later crustal dilation due to dyke-emplacement of up to 70%. Two Ocean Drilling Program (ODP) cruises, Legs 152 & 163 with DLC participation and leadership have successfully penetrated the submerged parts of the offshore seaward-dipping reflector sequences (SDRS) that are interpreted as subaerially erupted lava flows. The results show that vigorous magmatism initiated as early as 61–60 Ma, i.e. 5-6 m.y. prior to formation of an oceanic spreading ridge system. Two large and successful seismic experiments (partly joint with the Woods Hole Oceanographic Institution) have further demonstrated a temporal variation in thickness of the SDRS and established that these extend considerably further seawards and southwards from the proposed mantle plume track than previously thought. One of the implications is that the North Atlantic "ocean floor" formation was subaerially exposed along a 2500 km long spreading axis 1–3 m.y. after break-up, and that this spreading axis stayed above sea-level for at least 6 m.y. after break-up over an at least 1000km long ridge segment. Continued research will concentrate at understanding the driving forces behind rift localisation, break-up geometry and extension, and will try to describe the interaction between mantle plumes and lithosphere through time. On the basis of the present study area in the North Atlantic parallels will be drawn to other examples of continental break-up in the vicinity of mantle plumes.

S. B. & F. M., Dansk Lithosfærecenter, Øster Voldgade 10, 1350 København K. 17 February 1997.