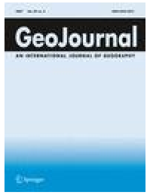

The Fennoscandian uplift and late cenozoic geodynamics: geological evidence

Journal	GeoJournal
Publisher	Springer Netherlands
ISSN	0343-2521 (Print) 1572-9893 (Online)
Issue	Volume 3, Number 3 / May, 1979
DOI	10.1007/BF00177634
Pages	287-318
Subject Collection	Earth and Environmental Science
SpringerLink Date	Wednesday, October 27, 2004

N.-A. Mörner[1]

(1) Geological Institute, Stockholm University, Box 6801, S-11386 Stockholm, Sweden

Abstract The history of the recording and interpretation of the Fennoscandian uplift illustrates the main history of Earth sciences because the results obtained had (and still have) immediate impact of the interpretation of a large number of fundamental problems in Earth sciences. Thanks to a paper of De Geer in 1888, the glacial isostatic origin was established. Fennoscandia became the classic area of glacial isostasy, and its sea level records were used for geophysical calculations of the properties and dynamics of the mantle and crust. The varve dated sea level curve of Lidén (1938) from the center of uplift provided an exceptionally well dated record. With the radiocarbon method, the records of shorelines and shorelevel displacement curves were drastically improved providing a totally new basis for the understanding of the geodynamics of the Fennoscandian uplift and for the geophysical interpretation of the data obtained. This is especially true in combination with the repeated levelling data obtained during the last decades for Finland and Sweden.

The Late Cenozoic long term movements of the Fennoscandian Shield are characterized by a considerable subsidence. The postglacial uplift of Fennoscandia is complex (an exponential and a linear factor) and caused by two different mechanisms. The total absolute movement in relation to the last glaciation is an elliptic uplift cone of 830 m height surrounded by a subsidence through of 170 m height. The mass in the uplift cone and in the subsidence through is as 1:1 with a volume $0.7 \times 10^6 km^3$. The disappearence/appearance of mass give evidence of a mass transfer in a low viscosity asthenosphere. The properties and conditions of the asthenosphere are found to be: $1–10 \times 10^{20}$ Poises in viscosity, $3 \times 10^{-14} – 3 \times 10^{-16}$ sec^{-1} in strain rates, 0.7% of the melting temperature, 3 mm in grain size, and 5–0.4 bar in stress. The main isostatic uplift (the exponential factor) originates from an asthenospheric dislocation glide process which in early-mid Holocene time changed over into a diffusion creep process. The present linear uplift factor (identified through the last 8000 yrs) seems to originate from mesospheric motions under the following approximate conditions: 0.6% of the melting temperature, 2×10^{22} Poises in viscosity, 3×10^{-16} sec^{-1} in strain rates and 8 bars in stress. Uplift irregularities and neotectonism are frequently established and often reveal an old geodynamic inheritance (e.g. the Pre-Baikalian/Gothian bedrock seam of high geodynamic activity). The peak rates of glacial isostasy are associated with intensive fracturing, faulting and seismic activity.

Referenced by

10 newer articles

1. Mörner, Nils-Axel (1991) The Fennoscandian Rebound. *Terra Nova* 3(4) [CrossRef]
2. Mörner, Nils-Axel (1991) Course and origin of the Fennoscandian uplift: the case for two separate mechanisms. *Terra Nova* 3 (4) [CrossRef]
3. Ekman, Martin (1991) A concise history of postglacial land uplift research (from its beginning to 1950). *Terra Nova* 3(4) [CrossRef]
4. MORNER, NILS-AXEL (1987) Climatic and glacial changes during the last 150, 000 years within the Arctic-European-Atlantic sector. *Polar Research* 5(3) [CrossRef]
5. Sjöberg, R. (1991) Measurement and calibration of weathering using the schmidt hammer, on wave washed moraines on the upper norrland coast, Sweden. *Earth Surface Processes and Landforms* 16 (1) [CrossRef]
6. Henrich, Rüdiger (1995) Controls on modern carbonate sedimentation on warm-temperate to arctic coasts, shelves and seamounts in the Northern Hemisphere: Implications for fossil counterparts. *Facies* 32 (1) [CrossRef]
7. Mörner, N. -A. (1981) Eustasy, paleoglaciation and palaoclimatology.

Fulltext Preview (Small, Large)

GeoJournal 3.3 287–318/1979 287

The Fennoscandian Uplift and Late Cenozoic Geodynamics: Geological Evidence

Mörner, N.-A., Dr., Geological Institute, Stockholm University, Box 6801, S-11386 Stockholm, Sweden

Abstract: The history of the recording and interpretation of the Fennoscandian uplift illustrates the main history of Earth sciences because the results obtained had (and still have) immediate impact of the interpretation of a large number of fundamental problems in Earth sciences. Thanks to a paper of De Geer in 1888, the glacial isostatic origin was established. Fennoscandia became the classic area of glacial isostasy, and its sea level records were used for geophysical calculations of the properties and dynamics of the mantle and crust. The varve dated sea level curve of Lidén [1938] from the center of uplift provided an exceptionally well dated record. With the radiocarbon method, the records of shorelines and shorelevel displacement curves were drastically improved providing a totally new basis for the understanding of the geodynamics of the Fennoscandian uplift and for the geophysical interpretation of the data obtained. This is especially true in combination with the repeated levelling data obtained during the last decades for Finland and Sweden.

The Late Cenozoic long term movements of the Fennoscandian Shield are characterized by a considerable subsidence. The postglacial uplift of Fennoscandia is complex (an exponential and a linear factor) and caused by two different mechanisms. The total absolute movement in relation to the last glaciation is an elliptic uplift cone of 830 m height surrounded by a subsidence through of 170 m height. The mass in the uplift cone and in the subsidence through is as 1:1 with a volume $0.7 \times 10^6 km^3$. The disappearence/appearance of mass give evidence of a mass tramfer in a low viscosity asthenosphere. The properties and conditions of the asthenosphere are found to be: $1-10 \times 10^{20}$ Poises in viscosity, $3 \times 10^{-14} - 3 \times 10^{-16}$ sec^{-1} in strain rates, 0.7 % of the melting temperature, 3 mm in grain size, and 5–0.4 bar in stress. The main isostatic uplift (the exponential factor) originates from an asthenospheric dislocation glide process which in early-mid Holocene time changed over into a diffusion creep process. The present linear uplift factor (identified through the last 8000 yrs) seems to originate from mesospheric motions under the following approximate conditions: 0.6 % of the melting temperature, 2×10^{22} Poises in viscosity, 3×10^{-16} sec^{-1} in strain rates and 8 bars in stress. Uplift irregularities and neotectonism are frequently established and often reveal an old geodynamic inheritance (e.g. the Pre-Baikalian/Gothian bedrock seam of high geodynamic activity). The peak rates of glacial isostasy are associated with intensive fracturing, faulting and seismic activity.

vidi ego, quod fuerat quondam solidissima tellus,
esse fretum, vidi factas exaequore terras;
et procul a pelago conchae iacuere marinae,
et vetus inventa est in montibus anchora summis;
quodque fuit campus, vallem decursus aquarum
fecit, et eluvie mons est deductus in aequor,
eque paludosa siccis humus aret harenis,
quaeque sitim tulerant, stagnata paludibus ument.
hic fontes natura novos emisit, et illic
clausit, et aut imis commota tremoribus orbis
flumina prosiliunt, aut exsiccata residunt.

P.N. Ovidius (43 BC – 17 AD): Metamorphoses XV: 262–272

I have myself seen what once was most solid ground
disappear in the sea, and I know of land risen from the sea;
and sea-shells have been found lying far from the ocean
and ancient anchor on a mountain top; and a former level
plain was turned into a valley by the running water,
and a mountain was levelled by erosion to a plain, and a
former swampy marsh is now dry land and what was
dry land is now a marshy pool. Here nature sends forth
new fountains, there seals them off, and stirred by
quaking in the earth rivers spring forth or dried run out.

References secured to subscribers.

Geologische Rundschau 70 (2)
[CrossRef]
8. MAGNHAGEN, C. (2001) Gape size allometry in pike reflects variation between lakes in prey availability and relative body depth. *Functional Ecology* 15(6)
[CrossRef]
9. Nesbo, C. L. (1998) Genetic Differentiation Among Stationary and Anadromous Perch (Perca Fluviatilis) in the Baltic Sea. *Hereditas* 129 (3)
[CrossRef]
10. Kiden, P. (2002) Late Quaternary sea-level change and isostatic and tectonic land movements along the Belgian-Dutch North Sea coast: geological data and model results. *Journal of Quaternary Science* 17(5-6)
[CrossRef]