The geoid topography is a direct measure of the irregular density distribution within the Earth. Hence, the geoid is an important tool in deciphering the internal structures and conditions. Deformations of the geoid - i.e. the mean sea level - with time, therefore, give evidence of density changes within the Earth. Past sea level changes that can be shown not to originate from tectonic processes, changes in the oceans' water volume, changes in the oceans' basin volumes or local dynamic sea level effects are found to represent paleo-geoid changes (Mörner, 1976, 1981a, 1983a). Such paleogeoid changes have now been identified for time units ranging from a few years to several million years (Mörner, op. cit.). This gives evidence of rapid processes within the Earth changing the density distribution; i.e. it gives evidence of a high-dynamic Earth.

1. THE PRESENT GEOID TOPOGRAPHY

The present geoid topography, or relief, has a maximum difference of about 180 m (between New Guinea and the Maldive Islands). The crustal and lithospheric contribution to the geoid relief seems to be in the order of 18 m (Sandwell & Schubert, 1980), i.e. 1/10 of the total relief. Hence, the major part of the geoid topography relief (about 9/10) must originate from sub-crustal density irregularities.

The recent high-resolution geoid topography solutions reveal the short wave-length relief in the geoid surface. Trenches, mid-oceanic ridges, gyots, pinnacle islands, etc. are now well recorded.

2. THE PALEOGEOID: CHANGES AND ORIGIN

Paleo-sea-level analyses (Mörner, 1976, 1980, 1981a, 1983a; Newman et al., 1980, 1981) indicate that the geoid has constantly been changing. The rates of these changes, in general, significantly exceed those of glacial eustasy and tectono-eustasy (Mörner, 1983a). Rapid paleogeoid changes must lead their origin in special processes within the Earth that are capable of changing by such rates (as discussed below).
The greatest density contrast is at the core/mantle interphase at about 2900 km depth. Differential movements of the core and the mantle may give rise to considerable gravity redistributions. In order to have any significant power at the Earth's surface, however, there need to be some corresponding deformations and amplifications in the mantle above (Mörner, 1984, Fig. 10). Because of frequent observations of a correlation between paleogeoid changes and geomagnetic field anomalies (excursions) during the Late Pleistocene and Holocene (e.g., Mörner, 1978), a mutual origin in core/mantle changes was originally advocated (Mörner, 1976, 1980a).

The phase-transitional zone olivine/spinel at about 420 km depth and spinel/oxides at about 670 km depth are likely to play an important role for the creation and changes of the geoid relief. Phase-transitions of these zones may occur very "rapidly". Trubitsyn (1979) has shown that a 1 bar change in pressure at the 420 km level would move the olivine/spinel boundary by 3.8 m, which at the surface would be noted as an about 20 cm deformation of the geoid; an event that would only take 10 hours.

Melting of basalt decreases the density by 0.3 g/cm$^3$. A 5-7% partial melting in the upper mantle (i.e. the asthenosphere) would decrease the density by about 0.02 g/cm$^3$ (Faynberg, 1979). The creation of a 50 km thick partially melted layer or the expansion of such a layer by an additional 50 km would create a geoid anomaly in the order of 100 m (i.e. of the same order as the great geoid low over the Maldive Islands). This is especially interesting in view of the fact that the asthenosphere (as we know it today) probably was formed during the last 200 Ma (Mörner, 1983b).

The geoid low over the Maldive Islands is almost certainly younger than the passing of the Indian plate on its way north and the formation of the Himalayas, i.e. younger than about 30 Ma (or even less).

The phase-transition between granulite and eclogite at the crustal base and uppermost lithospheric mantle has turned out to be very interesting in this respect. Granulite has lower density and is magnetic, whilst eclogite has higher density but is virtually non-magnetic. Displacements of the granulite/eclogite boundary will give rise to decreased gravity (falling geoid) plus increased geomagnetism or increased gravity (rising geoid) plus decreased geomagnetism (Mörner, 1984). This is exactly what is observed; viz. in Holocene records (Mörner, 1978, 1980) and in comparisons between maps of gravity and magnetism (von Frese et al., 1983). It also offers an explanation why there can be a significant geomagnetic power from the "lithospheric field" also in the lower spherical harmonics (Mörner, 1983c) and why this field exhibits deformations with time.

The very short wave-length geoid anomalies offer special interpretations. Gyots and pinnacle islands seem to cause very local geoid rises in the order of up to 4 m. It is of great interest that such a geoid "bubble" (of about 1.5 m) in the Caroline Islands was related to no known gyote or pinnacle island and that a rapid search for such structures (Keating & Lazarewicz, 1983) failed to find any. The explanation seems to be either that the expedition searched on not exactly the right spot (the location on the geoid map is, of course, not perfectly exact) or that the signal comes from a structure that has not yet penetrated the ocean floor. The largest geoid signal is likely to occur at the early phase of the formation of gyots and pinnacle islands, later to tend to be nivellated.