TRIASSIC MARGINAL BASINS OF NORTHERN AND EASTERN EUROPE AND EVIDENCE FOR GLOBAL SEA-LEVEL FLUCTUATIONS

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ABSTRACT

By Triassic time, the West European Hercynides were attached to the ancient East European platform, forming the Great European continent in the centre of Laurasia. Lower Triassic strata were deposited in two epicontinental basins located on the northern margin of the European continent: the western basin (Germanic), represented by the Buntsandstein facies; and the eastern basin (Russian), represented by the Lower Triassic Vetlugian and Yarenskian series. In the southern part of the East European platform, Lower Triassic sediments were also deposited in the Pripjatsko-Dneprovsko-Donetski (PDD) trough. It has been proposed that the Germanic and Russian basins and PDD trough originally constituted a single basin, termed the "Paleobaltic" (Lozovsky et al., 1984). The Paleobaltic was connected with the Tethys Ocean via the PDD trough attaining the Manytch and Mangyshlak depressions and the Pre-Caspian syneclise, where marine limestone with typical Tethyan fauna is found.

Three Lower Triassic transgressive-regressive (T-R) cycles have been established in the Russian basin: Induan, lower Olenekian, and upper Olenekian (Lozovsky et al., 1984). Analogous T-R cycles have been established in the Sverdrup basin (Embry, 1988), in other parts of the Arctic basin (Mørk et al., 1989), and in the Tethyan region (Lozovsky, 1989, 1990). These T-R cycles were possibly generated by global eustatic sea-level fluctuations.

INTRODUCTION

By Triassic time, the West European Hercynides were attached to the ancient East European platform, forming the Great European continent in the centre of Laurasia. To the north, the Boreal Sea occupied the territory of the modern Arctic Ocean and part of the margins of the surrounding continents--Lower Triassic marine sediments are well known from outcrops and wells throughout the Boreal realm (Greenland, Svalbard, Canadian Arctic Archipelago, Verkhoyansk, etc.). To the south, the Tethys Sea covered portions of the European and North American platforms.

GERMANIC BASIN, RUSSIAN BASIN, AND PDD TROUGH

At the beginning of Triassic time, two epicontinental basins were located on the northern margin of the European continent (Fig.1). The western, or Germanic, basin is represented by the Buntsandstein facies, which developed from England to Lithuania and was penetrated by wells in the North Sea. Here the lower, and sometimes the middle, Buntsandstein lies unconformably on beds ranging in age from Zechstein to Precambrian. The areal distribution of the Buntsandstein is twice as large as the preceding saline Zechstein facies (Szyperko-Teller and Moryc, 1988).

The eastern, or Russian, basin is represented by the Lower Triassic Vetlugian series subdivided into four units (Vokhmian, Rybinskian, Sludkian, and Ustmylskian) and overlain by the Yarenskian series composed of the Fedorovskian and Gamskian units. In the Moscow syneclise, the Vokhmian and sometimes the Rybinskian lie on various units of Tatarian age. To the northeast, the area of Lower Triassic deposits is interrupted by the Timan high. East of the high, Triassic sediments are found in the Timan-Pechoria syneclise and in the depression of the Pre-Ural foredeep.

In the southern part of the East European platform, there is also a vast area of Lower Triassic sediments in the Pripjatsko-Dneprovsko-Donetski (PDD) trough and in the Pre-Caspian syneclise. Here, the age of underlying rocks ranges from Tatarian to Precambrian. Strata in the Pre-Caspian structure correlate with Lower Triassic deposits on the Scythian and Turanian plates, where they lie unconformably on the deformed rocks of Hercynian basement.

All of these areas of Lower Triassic sediment deposition were interconnected in the past but are now separated by modern structures. Triassic basins were surrounded by Hercynian orogens on the east (Ural Mountains) as well as on the southwest (Ardenn, Rhenish, and Bohemian massifs). By the beginning of the Triassic, these orogens were still highly elevated and supplied the bulk of terrigenous material. Coarse-grained facies, consisting of conglomerates, were developed near the orogens. As the distance from the orogens increased, the conglomerates were replaced by cross-bedded sandstones with features typical of fluvial deposits. These fluvial strata change facies to finely bedded lacustrine strata. Toward the center of basins, the lacustrine facies is replaced by marine facies. The latter are characterized by their carbonate content and by the presence of ooliths (sometimes with glauconite in the nucleus) and marine pelecypods. These marine facies are developed in the western part of the Moscow syneclise in the region of the Upper Volga. The Lower Triassic section there is very similar to that of the Polish-Lithuanian syneclise (extreme eastern part of the Germanic basin), although they are currently separated by the Latvian sill.

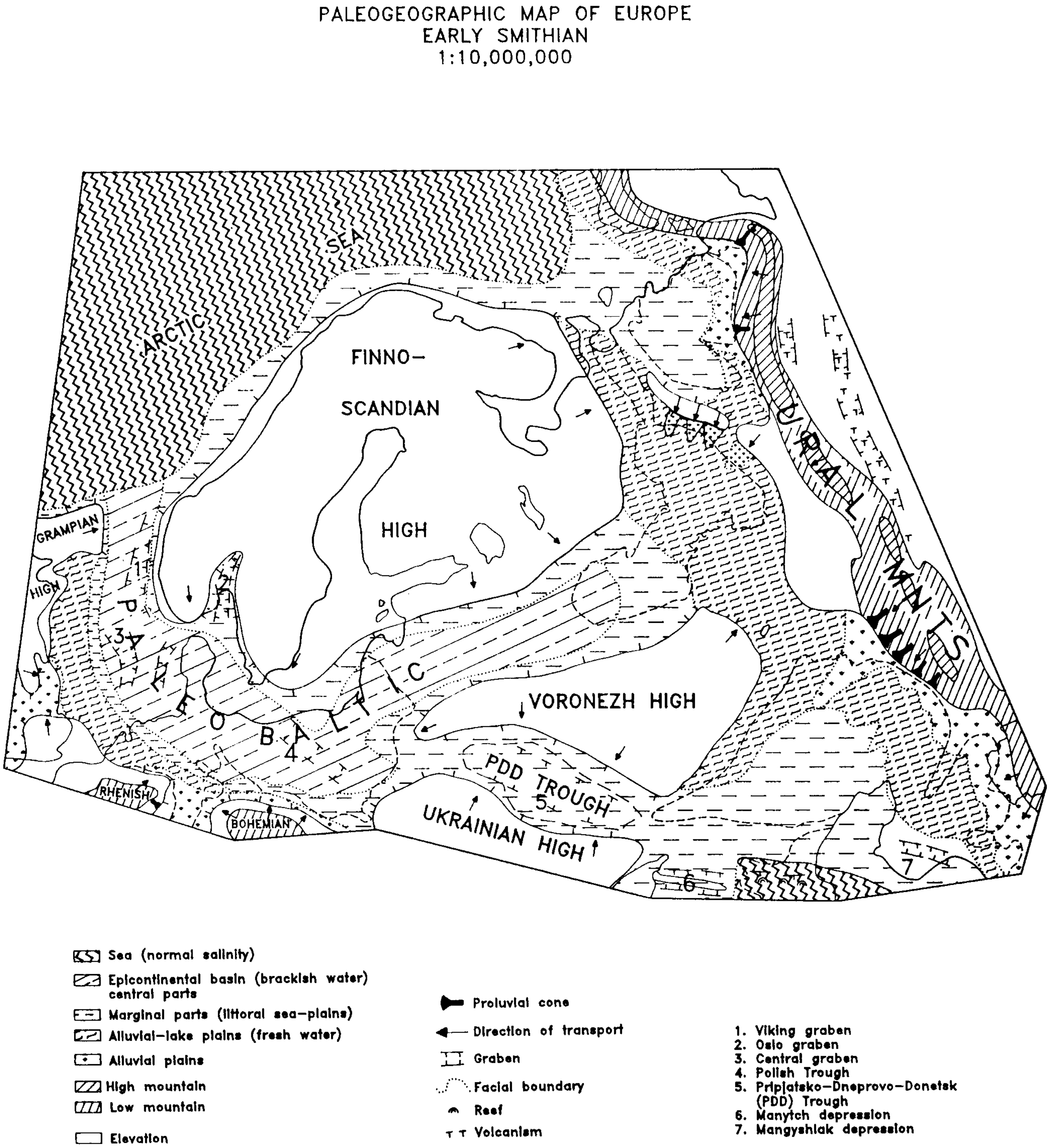

Fig.1. Paleogeographic map of Europe in the early Smithian: Depositional environments (this page); Lithologies (facing page).

Lozovsky et al. (1984) proposed that, originally, the Germanic and Russian basins formed a single basin named the "Paleobaltic." One of the peculiarities of the Paleobaltic was the decrease of salinity from west to east, a phenomenon also observed in the modern Baltic Sea. Evidence for this is the change of ostracod complexes from brackish-water forms to fresh-water forms in the Upper Permian and Lower Triassic (Lozovsky et al., 1984). The connection of the Paleobaltic with the Triassic Boreal Sea occurred through the Viking graben between the Finno-Scandian and Grampian highs.

PALEOGEOGRAPHIC MAP OF EUROPE
EARLY SMITHIAN
1:10,000,000

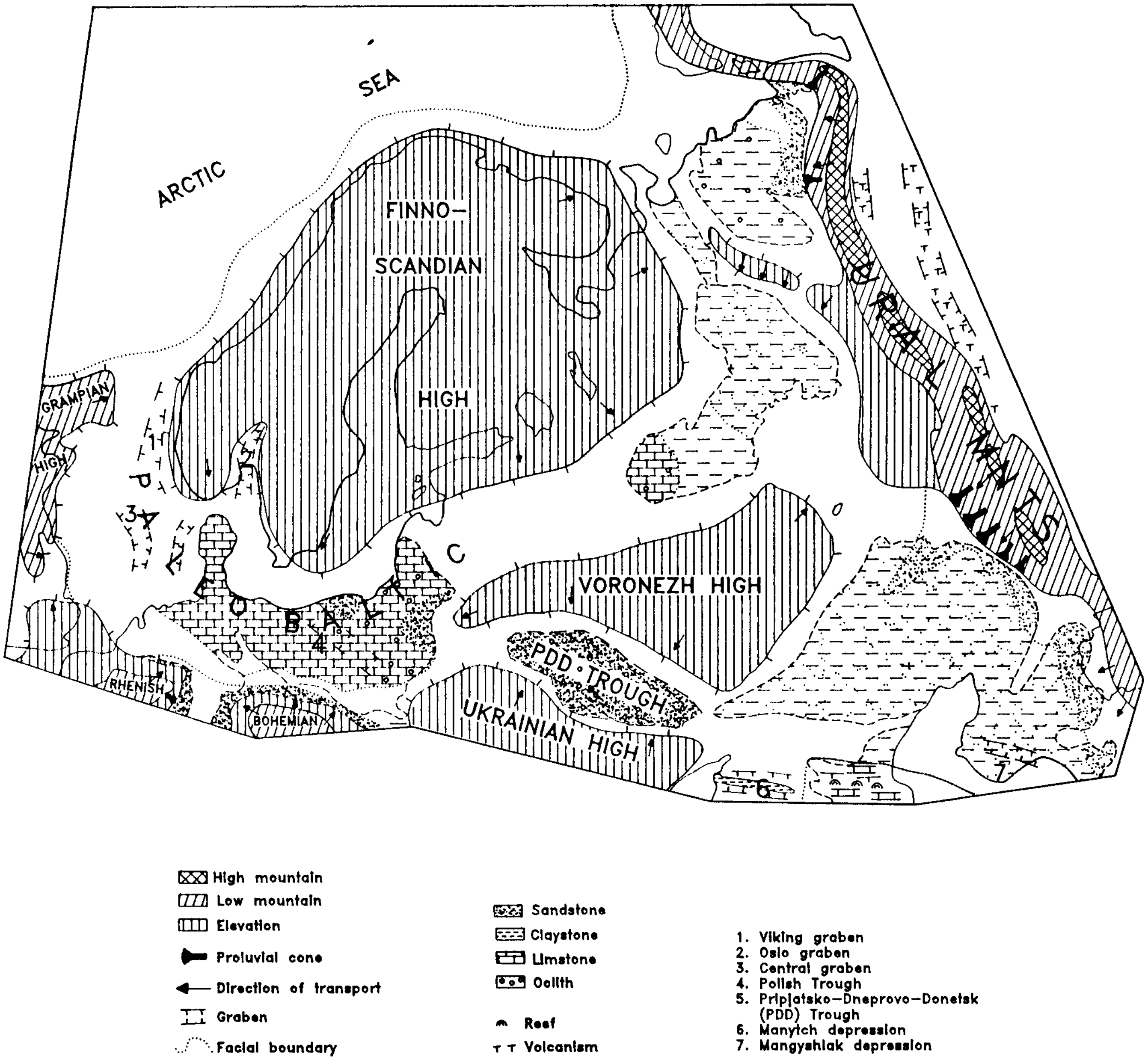

Fig.1. ***(Continued).***

The PDD trough formed a shallow gulf of the Paleobaltic where sand with ooliths accumulated. It was located between the Voronezh and Ukrainian highs and is now separated from the Germanic basin by a small ridge. It is interesting to note that the Paleobaltic reminds us in its contours of the modern Baltic Sea (with Gulfs of Bothnia and Finland), although the modern Baltic is, of course, much smaller. The Paleobaltic was connected with the Tethys Ocean via the PDD trough attaining the Manytch and Mangyshlak depressions and the Pre-Caspian syneclise, where marine limestone with typical Tethyan fauna is found.

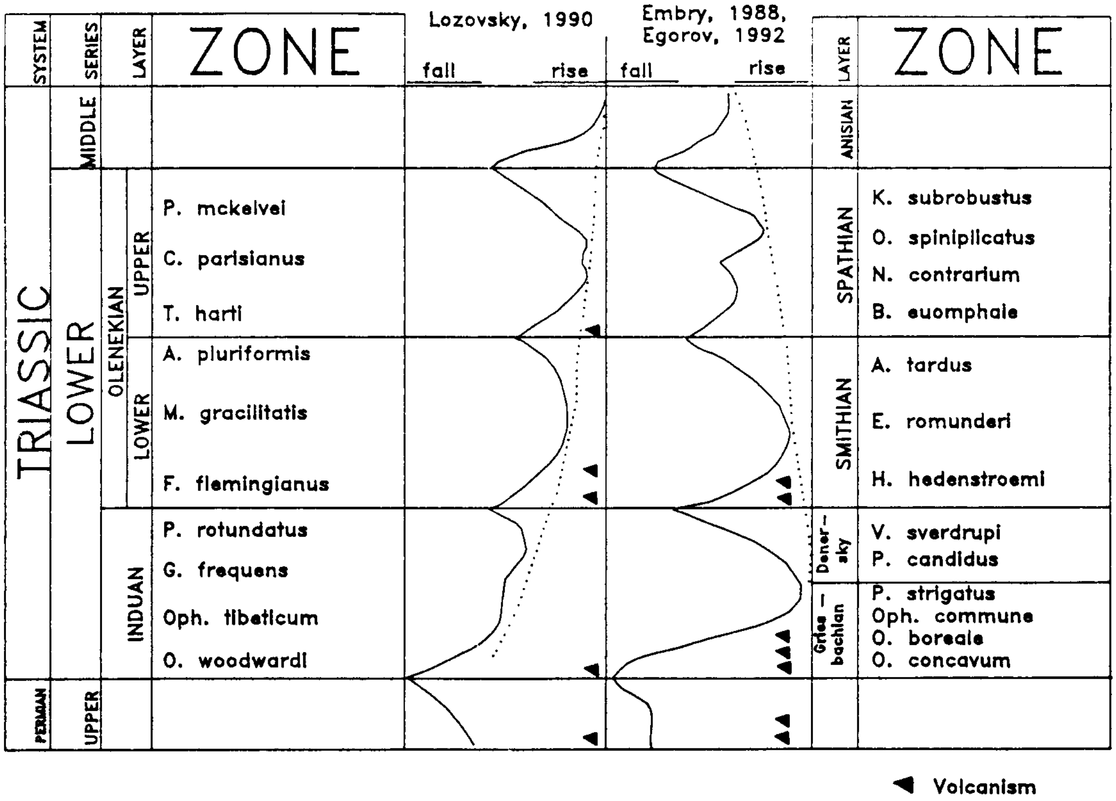

Fig.2. Curves of sea-level fluctuations in the Tethyan basin (left) and Boreal basin (right).

TRANSGRESSIVE-REGRESSIVE CYCLES

Three transgressive-regressive (T-R) cycles occur in the Lower Triassic section of both the Russian and Germanic basins. These cycles were established in rocks of the Moscow syneclise for the Late Permian and Early Triassic by Lozovsky et al. (1984). Each cycle begins with relatively deep-water sediments typically consisting of thin-bedded clays, sometimes with limestone beds (lacustrine or basin facies), which occupy a vast area and rest unconformably on underlying beds (transgressive phase). The top part of each cycle is formed by sediments that covered a smaller area and were deposited in shallow-water or subaerial conditions with a predominantly fluvial environment (regressive phase). Fluvial facies are also usually seen at the base of the overlying cycle.

Various methods of correlation for continental and marine formations (palynological and paleomagnetic) and analysis of transitional sections containing both ammonite and vertebrate fauna (for instance, the East Greenland section) allow the correlation of the first cycle with the Induan, the second with the lower Olenekian (Smithian), and the third with the upper Olenekian (Spathian). Lozovsky et al. (1984) attributed the origin of these T-R cycles to sea-level fluctuations. This mechanism operated not only on the marine shelf but also on the alluvial-lake plains of the surrounding continents hydraulically connected with them. During the rise of sea level (transgressive phase), the mouths of inflowing rivers were inundated until the marine ingression. This resulted in the wide development of lake and flood facies. A sea-level decrease (regressive phase) produced a new profile of equilibrium, reviving the river systems on the alluvial-lake plains and resulting in the spread of fluvial facies.

Embry (1988) established three T-R sea-level cycles in the marine Lower Triassic sediments of the Sverdrup basin beginning in the earliest Griesbachian, the earliest Smithian, and the late Smithian, respectively. Analogous cycles, especially the older two, have been recognized in other parts of the Arctic basin (Mørk et al., 1989). I propose that the third cycle starts at the beginning of the Spathian, as is shown by Egorov (1992). This is confirmed by the absence of the *Dieneroceras demokidovi* zone in the Canadian type sections (Tozer and Dagys, 1989).

Three T-R sea-level cycles (Induan, lower Olenekian, and upper Olenekian) have also been recognized in the Tethyan province based on the analysis of sections located in the southern part of the East European platform and in the western part of the North American platform (Lozovsky, 1989, 1990). Analysis of the principal Lower Triassic sections of the Tethyan region confirms this conclusion. The age of the cycles is proved by the ammonoid fauna. Analogous and age-equivalent cycles can be recognized in the surrounding epicontinental basins and the alluvial-lake plains connected with them. On a curve published recently for the Germanic basin by Aigner and Bachman (1992), it is possible to distinguish these same cycles, with some complications in the third cycle.

DISCUSSION

Comparison of the curve of sea-level fluctuations established for the Tethyan region (Lozovsky, 1989, 1990) with that by Embry (1988) for the Sverdrup basin (Fig.2) indicates that there were three synchronous transgressions in the Tethyan and Boreal regions, and these can be explained by eustatic fluctuations of sea level during the Early Triassic. There are essential differences between these curves, however. In the Tethyan basin, transgressions increased in amplitude from oldest (Induan) to youngest (upper Olenekian). This tendency continued to the beginning of the Anisian. The reverse is true in the Boreal basin, where the amplitude of the transgressions decreased over time.

A possible explanation for this phenomenon may be found in the mutual action of two factors. The first, synchroneity of transgressions, may be due to a change of ocean volume brought on by the mechanism of seafloor spreading, which acts simultaneously on our planet. The second, differences in transgression amplitude at the high and low latitudes, may be explained by the factor of rotation of the Earth on its axis (Fig.3), where rotational acceleration causes the rise of sea level in the high latitudes (polar transgression) and the fall of sea level in the low latitudes (equatorial regression). If only the action of the latter model were operating, we should record evidence of polar transgressions simultaneous with equatorial regressions, as some workers believe (Khramov et al., 1982). However, as shown above, reality is more complicated.

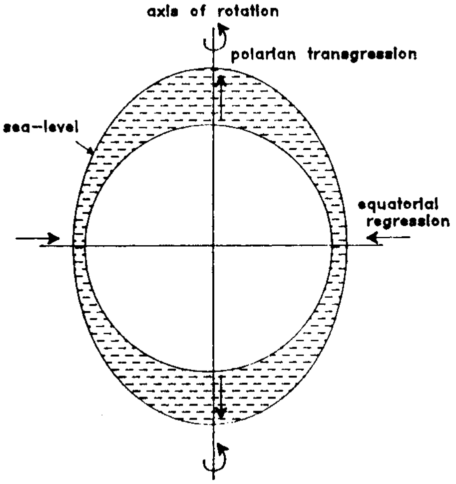

Fig.3. Effect of the Earth's rotational acceleration on sea level at high and low latitudes.

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