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The stratification and cyclicity of the Dachstein Limestone in Lofer, Leogang and Steinernes Meer (Northern Calcareous Alps, Austria)

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Abstract

The Dachstein Limestone of the Northern Calcareous Alps contains massive limestone beds, capped by dolomitic horizons. Groups of beds form bundles or stratification cycles and spectral analysis gives evidence of at least 3 orders of cycle frequencies. The regularity in the repetition of the limestones and dolomites was first pointed out by Sander (1936) [Sander, B., 1936. Beitrage zur Kenntniss der Anlagerungsgefuege. Mineral. Petrogr. Mitt. 48, 27–139] and the repetition of definite groups by Schwarzacher (1948, 1954) [Schwarzacher, W., 1948. Ueber die sedimentaere Rhytmik des Dachstein Kalkes von Lofer. Verh. Geol. Bundesanst. 1947 (Heft 10–12), 176–188; Schwarzacher, W., 1954. Ueber die Grossrhytmik des Dachstein Kalkes von Lofer. Tschermaks Mineral. Petrogr. Mitt. 4, 44–54]. The facies associated with the change from limestone to dolomite was interpreted by Fischer (1964) [Fischer, A.G., 1964. The Lofer cyclothems of the alpine Triassic. In: Merriam, D.F. (ed), Symposium on Cyclic Sedimentation. Kansas Geological Survey Bull. 169, 107–146] as an environmental change from lagoonal to peritidal and consequently as evidence of rising and falling sea level.

The present paper is based on the study of over 500 aerial photographs from the Loferer and Leoganger Steinberge and also on a detailed section, measured by Paul Enos and E. Samankassou in the Steinernes Meer. It was found that the Dachstein Limestone from Lofer and Leogang comprised about 35 stratification cycles of approximately 20 m thickness. This may correspond to a similar number of cycles in the Steinernes Meer where the spectral analysis gave a cycle thickness of 27 m and 13.6 m. The interpretation of the bundle as being caused by the 100 ka eccentricity cycle is considered tenable.

Keywords: Cyclicity; Carbonate platforms; Trias; Milankovitch

1. Introduction

The Dachsteinkalk (abbreviated DK) is a well-bedded limestone of Upper Norian to Rhaethic age, which is widely distributed throughout the Northern Calcareous Alps. The limestone oversteps the underlying dolomite (Hauptdolomit) progressively from north to south and eventually becomes a massive reef limestone. The bedded limestone is particularly interesting because of the regularity of the bedding. Its

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study has played an important role in developing explanations for the origin of sedimentary cycles.

Sander (1936) first pointed out that the regular repetition of bedding cycles is best explained by a time-periodic process. Schwarzacher (1948, 1954), observed the grouping of beds into bundles of approximately five, and he suggested that the 100 ka and 20 ka Milankovitch climatic variation may be the ultimate cause of the cyclic regularity of the stratification. Fischer (1964) identified and interpreted three phases in the DK cycle: phase C, is a massive limestone formed in relatively shallow lagoons. Phase B is represented by thinly bedded limestones and dolomites containing algal mats, mud cracks and desiccation pores indicating inter-tidal and possibly supra-tidal environments. Phase A is an immersion surface with evidence of erosion. The cycles are therefore a clear indication of relative changes in water depth. Fischer believed that they were caused partly by tectonic movements and possibly also by eustatic sea level changes.

Goldhammer et al. (1990), who measured a section of Dachstein Limestone, attributed the stratification to short-term variation in subsidence rates. Satterley (1996a,b) developed several arguments which he believed proved that the orbital control theory played no role in the process of cycle formation and developed instead a sedimentation theory in which the repeated shifting of mud banks and channels explained the DK cycles.

Accepting Fischer's facies interpretation in general terms, questions of how fluctuating water depths are recorded in areas with a varied topography and under different tectonic histories must be answered. For example, Zankl (1967) interpreted the patch-like distribution of algal mats as islands near the margin of the platform. Haas (1991) found different sequences of the facies A–B–C in different parts of the Hungarian Dachstein Limestones and he showed that differences in sequence have regional importance. Satterley (1996a) also showed considerable lateral variation of cycle formation and proposed a progradation of cycles towards the marginal reef of the platform.

For a further study of the cycle problem in the DK, cyclicity data from the mountain groups of the Loferer Steinberge, the Leoganger Steinberge and the Steinernes Meer will be compared. The three areas (Fig. 1) are in the province of Salzburg and are a part of very extensive carbonate platforms, which developed on the Northwest margin of the Tethys. The DK that rests on Norian dolomite (Hauptdolomit), continues through the Upper Norian and Rhaetic to the base of the Lias. Its thickness is very variable, being approximately 450 m in Leogang, 700 m–1000 m in the Steinernes Meer and at least 450 m in the Lofer Mountains. In Lofer, Lias is not found topping the

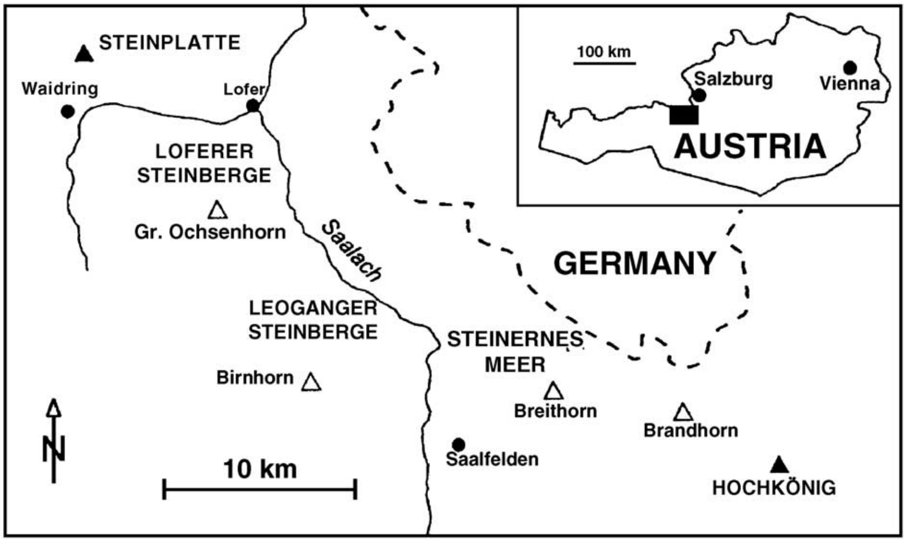

Fig. 1. Location of the study area (modified after Enos and Samankassou, 1998).