Geophysical Research Abstracts
Vol. 12, EGU2010-3475, 2010
EGU General Assembly 2010

Tethyan and German Triassic stratigraphy, correlation and numerical ages

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The correlation of the Germanic Triassic with the Tethyan Triassic is well constrained biostratigraphically. However, radiometric data are lacking and have to be imported for numerical calibration of litho- and chronostratigraphic units. These imported data can be extended to intervals without primary numerical data by astronomical calibration with Milankovitch cycles that are well recognisable in continental lake deposits of the Germanic Triassic, and correlated back to the marine realm. Such cross-correlation is a powerful method for improving numerical stage ages in the marine realm.

The calculations of numerical ages for the Germanic Lower and Middle Triassic by astronomical calibration are remarkably close to the subsequently published most recent radiometric data of different authors. For the Lower Triassic, up to the base of the Anisian, the 252.5 $\pm$ 0.3 Ma for the basal I. isarcica Zone at Meishan (Mundil et al., 2001) was taken as a reference value. On this base, Kozur (2003) calculated a numerical age of 252.6 Ma for the Permian-Triassic boundary, which age was later confirmed with new radiometric data by Mundil et al. (2004). Bachmann & Kozur (2004) correlated the base of the Stammen Beds (= base Thuringian Chirotherium Sandstone) with the Anisian base and calculated for this boundary 247 Ma. Lehrmann et al. (2006) used high-precision single zircon data for determination of the Anisian base at 247.2 Ma.

In the mainly marine Germanic Middle Triassic the radiometric data from the Tethyan Middle Triassic can be used after marine biostratigraphic correlation. Both the older (late Illyrian and Ladinian) and newer radiometric data (early and middle Anisian) fit well with the ages calculated by astronomical calibration.

The greatest problems are in the Upper Triassic, where very few radiometric data are known. At present there are mutually exclusive ages that have been proposed for the Carnian-Norian boundary, each based on radiometric dates. These conflicting data have produced a “short Norian model” and a "long Norian model." In the SW USA, there are several new radiometric data from which approximately 218 Ma can be calculated for the Norian base (Irmis & Mundil, 2008, and J. Ramezani, CPCP Meeting Albuquerque, May 2009). This value is close to the 216.5 Ma of the Norian base by Gradstein et al. (2004) and Ogg et al. (2008). From these data a duration of the Norian of 10.5-12 myrs results (short Norian model). Such contradicts, however, the 230.91 $\pm$ 0.33 Ma for the late early Tuvalian (Furin et al., 2006) and a corrected age of 231.4 Ma for the Tuvalian Adamanian LVF of Ishigualasto, Argentina (Irmis & Mundil, 2008) which would require a minimum duration of the Tuvalian of 14-15.5 myrs. The Tuvalian substage would then be longer than the entire Norian, which seems very improbable. The long Norian model of Gallet et al. (2003) placed the Norian base at $\sim$227 Ma in the lower Stockton Formation of the Newark Basin and estimated the duration of the Norian as $\sim$25 myrs. According to biostratigraphic data this Norian base lies within the middle Tuvalian, and the duration of the Norian is too long. Bachmann & Kozur (2004) and Kozur & Weems (2007) placed the Norian base between 223 to 226 Ma and assumed a Norian duration of 17-20 myrs. These data fit well with the Tuvalian radiometric ages (Lagonegro Basin, Furin et al., 2006; Ishigualasto, Irmis & Mundil, 2008), and with the basal Norian age of 225 $\pm$ 3 Ma from Alaska (Gehrels et al., 1987).