Characterizing conodont bioapatite from the early-triassic : an analytical and palaeoclimatological approach

ABSTRACT

The Early Triassic (252 to 247 Ma) was a dramatic period for life on Earth. This time range follows the Permian-Triassic boundary mass extinction (PTBME), the most catastrophic biotic crisis on Earth. This episode is thought to have been triggered by the consequences of magmatic activity associated with the Siberian Traps volcanism, which added significant levels of greenhouse gases into the atmosphere. For this reason, early assumptions were that the ecological recovery during the Early Triassic was delayed for all organisms. However, recent contributions have characterized it as a succession of short-term recovery-extinctions cycles, controlled by climatic oscillations as well as regional environmental variations. A major intra- Triassic extinction at the Smithian–Spathian boundary (SSB) was noted to be even larger in magnitude for secondary consumers compared to the PTBME. Studies of biotic crises in the geological past are important to understand, such that we can also better estimate the impacts that Earth's natural system may be facing in view of future climatic and environmental changes. To complement the palaeoclimatic perspective about this period, this thesis investigated conodont bioapatites through stable oxygen isotope measurements ($\delta_{18}O$), used as proxies to estimate palaeoenvironmental conditions and relative sea water temperature changes.

While conodonts are widely used biogenic archives for tracing changes in palaeoclimatic/ environmental conditions, they are sadly very small in size and often only occur in low abundances in some critical sections that might be useful for palaeoclimatic/environmental interpretations. Hence, this thesis examined the possibility of using only a few conodonts for a representative analysis of their oxygen isotope composition. In particular, the SIMS (Secondary Ion Mass Spectrometry) analytical approach was critically examined for biogenic phosphates in general. Questions on the microstructure and chemical distribution in conodonts and shark teeth were studied to establish routine analytical protocols that would aim at ultimately using only a number of individual specimens in order to get representative and precise analysis. Through micro-analytical techniques, we noted the influence of sample preparation and of analysing different bioapatite tissues in the SIMS results. As such this first part then opened up the possibility of studying specimens also from sections that only contain rare conodonts but that are of critical importance for an improved, global interpretation of changing climatic and environmental conditions in the past.

The second part of this thesis involves *in-situ* $\delta_{18}O$ analysis in Omani conodonts from two exotic carbonate blocks: one from a condensed section with low sedimentation rates and abundant specimens recovered per layer; and one from a time-equivalent, well-preserved extended section, where conodonts are only rarely found. The new oxygen isotope measurements from these two comparative sections did improve our knowledge about the progression of the climatic upheavals covering the Smithian–Spathian Boundary (SSB).

In the third part, results from different sections around the globe are compared, ranging from low to high palaeolatitudes and from both palaeo-oceans of the Early Triassic: the Tethys and Panthalassa. The findings of this chapter highlight differences in conodont oxygen isotope compositions recovered from distinct settings, and enhance the knowledge about the palaeo-oceanography and -circulation, the palaeosalinity and the local controls on different sections studied in the comparison, allowing for a more detailed view on global changes in palaeoenvironmental conditions and changes thereof.

Being part of a major SNF-funded project, the Mid-Early Triassic Extreme Climatic Oscillation (METECO) project, the products of this thesis should both complement future interpretations about the Early Triassic climatic context and contribute with quantifications of climatic changes.