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Geochronological constraints on the post-extinction recovery of the ammonoids and on the carbon isotope cycle during the Early Jurassic

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We present the first quantitative study of the early Jurassic recovery of ammonoids after a major extinction (end Triassic) based on extremely detailed U-Pb ID-TIMS geochronology placed within a clear phylogenetical framework and a biochronological analysis at the subzonal and species level. This study was made possible by our discovery of a rich Peruvian sequence of ammonites, deposited concomitantly with an unusually large number of ash beds. We also show the first ammonoid calibration of a complete d13Corg curve spanning the Hettangian in Nevada (USA). Our curve can be clearly characterized in terms of ammonoid fauna. The sequence starts with a Choristoceras crickmayi negative excursion corresponding to the classical upper Triassic "Initial CIE" of the British authors and ends with a large positive Angulaticeras excursion. This suggests that the major positive anomaly which was first observed in British Columbia has a Late and not an Early or Middle Hettangian age, as is usually assumed in the recent literature. This allows us to integrate the ammonoid recovery pattern with the carbon isotope data. We observe two major phases of rediversification in the P.spelae and Angulaticeras zones that correspond to positive peaks of our new d13Corg curve, providing a possible link between biodiversity and the global carbon cycle. The P.pacificum negative excursion records the final extinction of the genera Odoghertyceras and Choristoceras (minutum group).
In the case of the post-extinction recovery, the development of the earliest Hettangian ammonites occurs within the genus Psiloceras, which starts with the occurrence of P.spelae and then explodes with the worldwide development of smooth psiloceratids of the planorbis group s.l. This rapid biodiversification likely occurred less than 100 ka after the TJ crisis and Psiloceras occupied all the possible ecological niches worldwide, from the Pacific deep waters to the NW european shallow deposits and also in some rare tethyan occurrences like at Germig in Tibet. That global dispersion allowed the differentiation of the group in several major "phyla", the Schlotheimiidae, Discamphiceratinae, Arietitidae and Lytocerataceae, which were the roots of all other Jurassic and Cretaceous ammonites. Rapid diversification was probably enhanced by the appearance of multiple epicontinental basins during the fragmentation of the Pangea.