Palaeozoic palaeogeography in Hercynian and Appalachian belts by Sm-Nd isotopic studies of shales

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The Sm-Nd isotopic studies of shales give important informations about the crustal growth and the provenance of the sediments. Because shales integrate the diversity of eroded rocks and because the Sm-Nd isotopic system is left undisturbed by surface processes, the Nd isotopic initial composition reflects an average of the different mechanically eroded sources. This composition reflects a balance between juvenile inputs from the mantle by volcanism and reworked inputs from the continental crust. However, the Sm-Nd isotopic signal is a biased average in which pre-existing sediments and young mountains appear to be over represented. The Nd isotopic initial composition can be expressed by depleted mantle model ages (T_{DM}). Assuming that similar T_{DM} values can characterize a common tectonic domain, comparisons between data from several areas can give new palaeogeographical constraints. First, we test this assumption for the Hercynian belt and we expand it to the Appalachian belt in eastern Canada.

Our data from the Hercynian belt concern Sm-Nd isotopic data on 46 shales from the Montagne Noire (southern French Massif Central). The sedimentary record, which comprises one of the most complete Palaeozoic sequences in Europe, was sampled from Early Cambrian to Early Jurassic (560 to 180 Ma). This sequence is interrupted by two hiatuses. The first is situated in Middle Ordovician (490 to 450 Ma) and the second during Carboniferous (330 to 300 Ma). We analysed volcanogenic materials and lavas in order to identify possible source materials. During the studied time span, most of the T_{DM}'s are around 1.6 Ga. We observe some rapid T_{DM} changes toward older ages at 520 and 270 Ma and toward younger ages at 300 Ma. These variations are related to different sedimentary settings and to the volcanic event (300 Ma) detected in a continental basin. Our results indicate that in any case, younger T_{DM} do not reflect large Palaeozoic juvenile inputs related to orogenic processes in the south of the French Massif Central. We compare our data with others published data from Brittany (Medio North Armorican Domain) and from Spain (Central Iberian Domain and Cantabrian Domain). The similar T_{DM} calculated for these areas from Early Ordovician to Early Carboniferous (490 to 330 Ma) suggest that these three areas belonged to the same palaeogeographic entity at least for this time span. This contradicts models that propose there is an oceanic suture between Brittany and Spain and between the two Spanish zones. Conversely, our observations are in agreement with palaeontological data indicating that Brittany and Spain were adjoining during this time span. On the other hand, because the Montagne Noire has younger T_{DM} from 490 to ~ 400 Ma compare to Brittany and Spain, we propose that this area probably undergone a different tectonic evolution during this time span.

The Appalachian belt was created by several accretion events of exotic terranes to the North American shield (Laurentia) during the Palaeozoic. The origin, the timing and the link between the accreted terranes are a matter to debate. In order to give new constraints, we analysed shales from the Dunnage zone, which represent eroded products from the Laurentia, and shales from accreted terranes: the Avalon and Meguma zones. For the Dunnage zone, we observe a rapid T_{DM} shift toward younger ages near 440 Ma. This result is interpreted as an evidence for the accretion of Avalon to the Laurentia around that time.