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Rhynchonellid and spiriferid brachiopods as valuable tools for correlation of shelly faunas near the Devonian/Carboniferous boundary

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From the brachiopod viewpoint, the Latest Famennian (Strunian) is marked by radiations among rhynchonellids and spiriferids, which developed morphological characters heralding the early Carboniferous faunas. However, both orders suffered dramatic losses during the Hangenberg event, which occurred just below the Devonian/Carboniferous (D/C) boundary, and recorded a significant post-event recovery during the Tournaisian as was the case for the productids.

Due to their short stratigraphical range and their extensive geographical distribution, rhynchonellids and spiriferids are very useful to recognize the D/C boundary in the absence of conodonts and/or ammonoids in neritic facies.

Typically Late Famennian in age, several rhynchonellid taxa did not cross the D/C boundary such as the rhynchoporid *Araratella*, the trigonirhynchiids *Centrorhynchus* and *Paurogastroderhynchus*, the petsmariid *Megalopterorhynchus*, and the rozmanariids *Hadyrhyncha*, *Novaplatirostrum*, *Pugnaria*, *Rozmanaria* and *Tetragonorhynchus*. Cyrtospiriferids such as *Cyrtospirifer*, *Dichospirifer* and *Sphenospira* became extinct at the end of the Strunian.

The base of the Tournaisian recorded the first occurrences of several genera among the rhynchonellids such as *Allorhynchus* (Allorhynchidae), *Hemiplethorhynchus* (Trigonirhynchiidae), and *Shumardella* (Petasmariidae) concomitantly with the first apparitions of the spiriferids *Eomartiniopsis* (Martiniidae) and *Kitakamithyris* (Elythidae).

The D/C boundary can also be recognized on the basis of species belonging to genera which appeared in the Late Famennian and which crossed it. This is especially the case of the representatives of the rhynchonellid genera *Macropotamorhynchus* (Trigonirhynchiidae), *Rhynchopora* (Rhynchoporidae), and *Sedenticellula* (Stenoscismatidae). Among the Spiriferida, it is mainly the case of those of the family Spiriferidae (e.g. *Parallelora*, *Prospira*).

These data need to be complemented by those provided by productids known around the D/C boundary. Moreover, further work is required to reach a better assessment of the consequences of the Hangenberg event on brachiopods.

Sedimentology and geochemistry of the Permo-Triassic boundary section at Guryul ravine, Kashmir, India; and a comparison with the Texas Cretaceous-Tertiary boundary section

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The Permo-Triassic boundary at Guryul Ravine, Kashmir, as defined by the first appearance of *H. parvus*, is at +3.2 metres above the base of the Khunamuh Formation, a predominantly dark grey argillite unit with sporadic thin limestones, which rest on late Permian sandy limestones of the Zewan Formation. In the basal 3 metres of the Khunamuh Formation, several bioclastic limestones occur. The first two, within the lowermost 1 metre are coarse shell beds with hummocky cross-stratifications suggesting deposition from interference waves. Such deposits are often attributed to storm waves, though such waves are also generated by tsunami. Given the average grainsize of the bioclastic beds (coarse sand to granules), the waves forming the beds would need to range from amplitudes of 1 metre at 10 metres depth to 3 metres at 100 metres depth for long period waves of 1000 sec (typical of tsunami), to amplitudes of about 1 metre at 10 metres to 4 to 40 metres at 100 metres depth for short period waves of 25 to 10 seconds (more typical of storm waves). The background clay sediment suggests a deeper shelf environment closer to 100 than to 1 metres depth, and thus open ocean waves above 4 metres amplitude for both storms and tsunami (though most open ocean storm waves are at the 10 sec period end giving amplitudes of +40 metres). In the overlying 2 metres of the Khunamuh Formation, thin graded bioclastic beds may also have been deposited from such waning waves. The faunas in the basal 3 metres show no systematic taxonomic changes: and earliest Triassic faunas only appear with *H. parvus* at +3.2 metres. Major and trace element analysis shows no systematic changes in this basal 3.2 metres, though extreme fluctuations begin around +5 metres. Though framboidal pyrite indicates anoxia at +1metre, Th/U ratios remain high above 3 (the dysoxic/oxic transition) until +9 metres and Molybdenum isotopes suggest anoxic conditions began at +4 metres. The basal few metres of the Khunamuh Formation may thus have been deposited rapidly from successive storm or tsunami waves. This basal Khunamuh section closely resembles the Cretaceous-Tertiary boundary section in Texas, and may have been deposited in the same way from waning tsunami. However, preliminary Platinum Group Element (PGE) analysis of the Khunamuh section indicates terrestrial rather than extraterrestrial PGE values and ratios and thus a non-impact cause of any tsunami. Expanded sections, like Guryul ravine, need to be studied in detail to separate specific end Permian events which is not possible in more condensed sections like Meishan.