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Proposals for the redefinition of the Griesbachian substage and for the base of the Triassic in the Arctic regions.

BAUD A.* and BEAUCHAMP B.**

*Geological Museum, UNIL-BFSH2, CH-1015 Lausanne, Switzerland, aymon.baud@sst.unil.ch
** Geological Survey of Canada, Calgary, Canada, BBeaucha@NRCan.gc.ca

The base of the Triassic was proposed by Yin et al. (1996a) at Meishan (S China) section D, bed 27c with the FAD of the conodont *H. parvus* and this GSSP has been adopted by the International Commission on Stratigraphy (ICS, 2001). This formal GSSP adoption bears numerous consequences. One of them concerns the Griesbachian substage. According to Yin et al. (1996b) in their proposals for global correlation based on ammonoids and conodonts, the Permian-Triassic boundary interval can be subdivided in 6 units (PTBU) from the lower Changhsingian (PTBU 1) to the upper Griesbachian PTBU 6 and there is an overlap between the upper Changhsingian and the lower Griesbachian.

Following his discoveries of well preserved *Otoceras* n. sp (=*O. concavum*) and *O boreale* ammonoid fauna along an unamed creek on western Axel Heiberg Island, Canadian Arctic, Geological Survey of Canada's Emeritus Scientist Dr. E.T. Tozer christened the creek in question "Griesbach Creek" and correlated these *Otoceras* with the *Otoceras* fauna of the Himalaya, which then defined the base of the Triassic. He created the Griesbachian Stage as the first stage of the Triassic period and proposed Griesbach Creek as the stratotype for the Griesbachian (Tozer, 1967). At the Griesbach Creek stratotype (80° 28' N, 094°30'W), *Otoceras concavum*, the oldest ammonoid zone within the Blind Fiord Formation, occurs within a concretion-rich level between 6 and 20 m above the base. A silty shale bed rich in *Claraia* sp. appears 21.5 m above the base. The first *Otoceras boreale* is 15 m higher.

The Blind Fiord Formation is a unit of the Sverdrup Basin. Throughout the Permian and Triassic, the Sverdrup Basin was located along the northwestern margin of Pangea (about 40°N paleolatitude during the P-T Boundary Interval). The basin was surrounded by continental land masses to the north and south. Only narrow and probably shallow connections existed with nearby oceans during the Late Permian and Early Triassic, allowing exchange with the global ocean system.

In 1994, working with Dr. Charles Henderson, University of Calgary, we collected fossils and samples of shale and siltstone from different Arctic sections, two of which being the Griesbach Creek and Otto Fiord South sections. The latter from Ellesmere Island yielded conodonts extracted and determined by Henderson (Henderson and Baud, 1997). The conodont fauna can be be subdivided into four older to younger components:

a. conodonts associated with *Otoceras concavum* and comprising *Neogondolella* sp.cf. *subcarinata*, *N*. sp. aff. *changxingensis* (possibly similar to *N. orchardi,* Kozur, 1995, *N. meishanensis*, and possibly *N. deflectus;*
b. conodonts associated with the lower part of *Otoceras boreale* beds, comprising *N. taylorae* and *N. meishanensis*,
c. conodonts associated with the upper part of *Otoceras boreale* beds, comprising *N. taylorae*, *N. carinata*, *N.* sp.cf. *planata*, *N. tulongensis*, *N. meishanensis*, and *Hindeodus parvus*;
d. conodonts associated with *Ophiceras commune*, comprising *N. taylorae*, *N. carinata*, and *N.* sp.cf. *planata*.

As discussed in Henderson and Baud (1997), the *Otoceras concavum* beds correlate to PTBU 2 of Yin et al. (1996), the lower part of *Otoceras boreale* beds to PTBU 3, the upper part of *Otoceras boreale* beds to PTBU 4 and the *Ophiceras commune* to the PTBU 5.

It is interesting to note that *H. parvus* appears with *N. tulongensis*, *N. carinata*, and *N. planata* 34m above the base of the Blind Fiord Formation and lies above strata containing the *Otoceras concavum* and *O. boreale* zones which are associated with the conodonts *Neogondolella* cf. *changxingensis*, *N. meishanensis* and *N.* cf. *subcarinata* (1-3m), *N.* cf. *taylorae* (20-40m), indicating correlation with the upper Changhsingian.

A similar situation occurs in east Greenland, at Kap Stosch River 1 section, were *H. parvus* (Kozur, 1998, pl I/7) appears 35m above the base of the Wordie Creek Formation and overlies horizons of the *Hypophiceras triviale* and *O. boreale* zone with the conodonts *Neogondolella* cf. *changxingensis yini* (7m), *N.* cf. *taylorae* (9m), *H. typicalis, H. latidentatus praeparvus* (10m) indicating correlation with the upper Changhsingian (Kozur, written communication).

The first appearance of *H. parvus* is a datum that correlates equally well in the Boreal and Tethyan areas. It is important to note that this FAD of *parvus* occurs above *O. boreale* in the Sverdup basin and in E Greenland, within an interval between *O. boreale* and the first *Ophiceras commune*. As noted by Kozur (1998), this interval corresponds to the *Tompophiceras pascoei* zone of Siberia or upper *Metophiceras subdemissum* zone of Greenland. This FAD occurs within an evolutive cline of *Hindeodus* morphotypes.

According to Orchard and Krystyn (1998), the *Otoceras* fauna of Spiti with *O. woodwardi* co-occurs with *Ophiceras* and is more advanced than the Otoceras fauna of the Arctic. The FAD of *H. parvus* coincides with the FAD of *O. latilobatum* in the Selung section of Tibet and can be correlated to the upper boreale zone of the Arctic. Whereas *N. taylorae* appears at the same level as *H. parvus* in the condensed sections of the Tethys, in E. Greenland and on Ellesmere *N. taylorae* is recorded far below *parvus*, at the base of the *Otoceras boreale* zone (that is 14m below at Otto Fiord South section).

In the Sverdrup Basin, the upper Changhsingian comprises the *O. concavm* and the O. *boreale* ammonoid zones and the *N. changxingensis* and *N. meishanensis* conodont zones. In Greenland, this interval comprises the *Hypophiceras triviale* and the *H. martini* ammonoid zones and the *N. iranica* and *H. latidentatus praeparvus* zones.

The new definition of the Griesbachian substage, which is based upon the successive appearance of Gondolellids and *Hindeodus* species and the FAD of *H. parvus*, promotes large-scale inter-continental correlations. It corresponds to the former upper Griesbachian with an *Ophiceras commune* lower zone and a *Buckenites strigatus* upper zone. At Griesbach Creek section where no conodonts have been found, the correlative FAD of *H. parvus* is believed to occur 48m above the base of the Blind Fiord Formation, 4m above the last *O. boreale* occurrence and 6m below the first *Ophiceras*. The new redefined Griesbachian substage corresponds to the lower Induan stage that is the first stage of the Triassic. With this new definition, there is no longer an overlap between the upper Changhsingian of Meishan and the Griesbachian of Griesbach Creek, and the Griesbachian is once again contained within the Triassic, which was the original intent of E.T. Tozer.

References

Henderson, C., and Baud, A., 1997, Correlation of the Permian-Triassic boundary in Arctic Canada and comparaison with Meishan, China, in W. Naiwen, and J. Remane, eds., Stratigraphy: Proceedings of the 30th IGC, v. 11: Beijing, VSP, p. 143-152.

Kozur, H. W., 1998, Problems for evaluation of the Scenario of the Permian-Triassic boundary biotic crisis and its causes: Geologia Croatica, v. 51, p. 135-162.

Orchard, M.J. and Krystyn, L., 1998, Conodonts of the lowermost Triassic of Spiti, and new zonation based on Neogondolella successions. Rivista Italiana di Paleontologia e Stratigrafia, 104(3): 341-367.

Tozer, E. T., 1967, A standard for Triassic time. Bulletin - Geological Survey of Canada, 156, 103pp.

Yin, *H.*, W. *C.* Sweet, B. F. Glenister, G. V. Kotlyar, *H.* Kozur, N. D. Newell, J. Sheng, Z. Yang, and Y. Zakharov, 1996a, Recommandation of the Meishan section as the global stratotype and point (GSSP) for the basal Boundary of Triassic System. Newsletter in Stratigraphy, 34, p. 81-108.

Yin, *H.*, S. Wu, M. Ding, K. Zhang, J. Tong, F. Yang, and L. Xulong, 1996b, The Meishan section. Candidate of the global stratotype and point (GSSP) of the Permian-Triassic boundary (PTB), in *H.* Yin, ed., The Paleozoic-Mesozoic Boundary. Candidates of the Global Stratotype Section and Point of the Permian-Triassic Boundary: Wuhan, China University of Geosciences Press, p. 31-47.