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PII: S0012-8252(16)30183-0
DOI: doi:10.1016/j.earscirev.2016.07.008
Reference: EARTH 2290

To appear in: *Earth Science Reviews*

Received date: 6 May 2016
Revised date: 16 July 2016
Accepted date: 21 July 2016

Please cite this article as: Jiang, Haishui, Wignall, Paul B., Chen, Zhong-Qiang, Xie, Shucheng, Lai, Xulong, Song, Haijun, Wang, Lina, Comment on "Quantitative biochronology of the Permian–Triassic boundary in South China based on conodont unitary associations" by Brosse et al. (2016), *Earth Science Reviews* (2016), doi:10.1016/j.earscirev.2016.07.008

Comment on "Quantitative biochronology of the Permian–Triassic boundary in South China based on conodont unitary associations" by Brosse et al. (2016)

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Abstract: Recently, Brosse et al. (2016) have proposed the use of conodont Unitary Associations Zones (UAZs) to substantially modify the biostratigraphy of the Permian–Triassic transition and to redefine the Permian–Triassic boundary (PTB). However, in our opinion, the UAZ analysis presented by Brosse et al. (2016) is based on unreliable taxonomic data sets with unjustified taxonomic re-assessments. No evidence shows that the UAZ approach improves the biozone biostratigraphy currently used to date the PTB.

Keywords: Permian–Triassic boundary; Unitary Associations; conodonts; South China

Brosse, Bucher and Goudemand (2016) have proposed the use of conodont Unitary Associations Zones (UAZs) to substantially modify the biostratigraphy of the Permian–Triassic transition and to redefine the chosen level of the Permian–Triassic boundary (PTB), because of a perceived weakness of conventional interval zones. They state that these zones have diachronous boundaries caused by the first occurrences (FOs) of conodont species being subject to 'local ecological conditions, sampling effort and selective preservation'. However, conodont distributions also define the UAZs, and the latter therefore suffer from the same problems. As re-introduced in Guex et al. (2015), the Unitary Association Method mainly provides biochronological time scales of discrete UAZs defined by characteristic species. Strata lacking these characteristic species cannot be assigned to any zones but are, instead, termed "intervals of separation", which vary greatly in duration amongst sections.

The UAZ approach provides a much lower-resolution biostratigraphy than the existing conodont zones that are defined by the first appearance datum (FAD) of zonal species. For example, Brosse et al. (2016) established six UAZs over the Permian−Triassic transition. Among them, five UAZs were recognized from the Meishan section, South China. In contrast, seven conodont zones have been established from the same stratal interval of the same section by means of conventional biostratigraphical approaches (Jiang et al., 2007; Zhang et al., 2009; Jiang et al., 2011; Chen et al., 2015). Moreover, an even worse scenario appears in another well-studied PTB section in Shangsi, northern Sichuan Province, South China.

Therein, three UAZs are established by Brosse et al. (2016) in an interval with six conodont interval zones (Jiang et al., 2011). Thus, the UAZ approach generates a lower-resolution correlation scheme and leaves many strata undated. However, the key feature of the UAZs, according to Brosse et al. (2016), is their improved "accuracy". However, the so-called improvement is not due to the UAZ method itself, but to substantial taxonomic re-assessment of published conodont occurrences by Brosse et al. (2016). We interpret the discrepancy between the newly proposed UAZ correlations (Brosse et al., 2016) and current biozones to be due to the failure to use the most recent published conodont ranges from some key Chinese sections (i.e., Jiang et al., 2011; Chen et al., 2015).

To establish conodont UAZs, Brosse et al. (2016) studied six PTB sites, namely Meishan, Shangsi, Yangou, Dawen, Dajiang, and Wuzhuan, in South China with well-established conodont records. Surprisingly, stratigraphical ranges of some key conodont elements/zones in the Meishan, Dawen, and Bianyang sections were incorrectly placed when Brosse et al. (2016) undertook their UAZ analysis. In Meishan, these authors placed the base of the Hindeodus changxingensis Zone at the base of Bed 27 and the base of the Isarcicella staeschi Zone at the base of Bed 27d, but these have been placed at the bases of Bed 26 and Bed 28, respectively in the latest literatures (see Zhang et al. 2009; Jiang et al. 2011). The Dawen biostratigraphy uses the findings of Chen et al. (2009), but these authors failed to note the earliest studies of Liu et al. (2007), which has a significant impact on the chosen zonal boundaries (see discussion in Jiang et al., 2014). Jiang et al. (2015) also provided an

updated conodont ranges for the Permian–Triassic transition from the neighboring Bianyang section, ~13 km from Dawen. These updated conodont range data were not cited in Brosse et al.'s (2016) analysis.

The Wuzhuan section records a microbialite succession across the PTB. Brosse et al. (2015) found Hindeodus parvus in the upper part of the microbialite, and thus suggested that the first occurrence of H. parvus in Wuzhuan is later than that in the GSSP Meishan. H. parvus is also know form the upper part of the PTB microbialite beds in other sections (i.e., Wuzhuan), but it has also been detected in association with Clarkina changxingensis and other Permian species from the base of the microbialite deposits in other sections [i.e., Dawen (Liu et al., 2007), Dajiang (Jiang et al., 2014), and Cili (Wang et al., 2016)]. This is likely because the Permian conodonts have been concentrated as insoluble residues at karstification surfaces seen at the base of some microbialite beds and subsequently co-samled with Triassic conodonts (Chen et al., 2009; Jiang et al., 2014). Such effects, and the rarity of conodonts in microbialite facies, suggests caution must be exercised when assessing conodont ranges in microbialite beds.

Brosse et al. (2016) changed the identification of many conodont species reported from South China in earlier publications without discussions. Thus, the authors downgraded the status of many species to "indeterminate" but failed to explain the reasoning for the revisions. Furthermore, Brosse et al. (2016) also illustrated holotypes of several key PTB conodont species. Of these, the illustrated specimen of Isarcicella lobata is not the true holotype proposed by Perri and

Farabegoli (2003, plate 3, figures 21–23). This misallocation of holotypes and lack of explanation of some taxonomic data brings into question the reliability of their UAZ analysis.

The most important advantage of the UAZ study, as suggested by Brosse et al. (2016), is to improve the stratigraphical correlation and define precisely the PTB at the Meishan GSSP. These authors therefore placed the PTB 'within the interval of separation bracketed by UAZ_2 and UAZ_3'. However, UAZ_3 was only identified at the Meishan section, and was not located in the other five sections studied by Brosse et al. (2016). In fact, UAZ_2 is only defined in the Dawen and Meishan sections (see fig. 10 in Brosse et al., 2016). This means that the PTB cannot be determined by UAZs in five of the six studied sections. Even in Meishan, the PTB could not be located precisely, but was placed at some uncertain levels within Bed 26. As a result, the PTB cannot be precisely located using the UAZ approach. It is also worth noting that Brosse et al. (2016) incorrectly placed the boundary between the Changxing and Yinkeng formations at the contact between Bed 26 and Bed 27. Instead, the boundary of these two formations has been traditionally located at the contact between Bed 24 and Bed 25 (Yin et al., 2001).

Brosse et al. (2016) argued that the FOs of some conodont species may contradict one another in various sections, especially the FOs of H. parvus and H. praeparvus, and concluded that there were contradictory correlations by interval zones, which usually heavily rely on the sampling effort. In fact, the FOs and ranges of conodont species used in the UAZ analysis suffer the same bias, such as, conodont range data

from the Wuzhuan section used by Brosse et al. (2015) discussed above. Henderson (2006) differentiated the FO and the FAD, and pointed out that the FO of H. parvus merely indicates that they are within the range or biozone of H. parvus. It is true that the FO of H. parvus may be diachronous in various sections if the sampling effort was not sufficient. Obviously, this is not the case for the PTB sections in South China, in which the FO of H. parvus is likely synchronous (i.e., Jiang et al., 2015, fig. 3) because most of the PTB sections have been densely sampled and studied in the past decades. In contrast, the mass extinction losses are more complicated because clades died out diachronously in different habitats (Song et al., 2013).

In summary, the effort by Brosse et al. (2016) to improve the biochronostratigraphical subdivision and correlation is encouraged, but currently the UAZ approach does not provide an improvement on the use of conventional interval zones in the PTB interval. Instead, the UAZ analysis presented by Brosse et al. (2016) is based on unreliable taxonomic data sets with unjustified taxonomic re-assessments.

Acknowledgements

We thank Editor A. Strasser for his professional editorial work. We are very grateful to Hongfu Yin, Jinnan Tong and Yongbiao Wang for their suggestions and discussion.

References

Brosse, M., Bucher, H., Goudemand, N., 2016. Quantitative biochronology of the Permian–Triassic boundary in South China based on conodont Unitary Associations. Earth-Sci. Rev. 155, 153–171.

Brosse, M., Bucher, H., Bagherpour, B., Baud, A., Frisk, Å. M., Guodun, K., Goudemand, N., 2015. Conodonts from the Early Triassic microbialite of Guangxi (South China): implications for the definition of the base of the Triassic System. Palaeontology 58, 563–584.

Chen, J., Beatty, T.W., Henderson, C.M., Rowe, H., 2009. Conodont biostratigraphy across the Permian–Triassic boundary at the Dawen section, Great Bank of Guizhou, Guizhou Province, South China: implications for the Late Permian extinction and correlation with Meishan. J. Asian Earth Sci. 36, 442–458.

Chen, Z.Q, Yang, H., Luo, M., Benton, M.J., Kaiho, H., Zhao, L.S., Huang, Y.G., Zhang, K.X., Fang, Y.H., Jiang, H.S., Qiu, H., Li, Y., Tu, C.Y., Shi, L., Zhang, L., Feng, X.Q., Chen, L., 2015. Complete biotic and sedimentary records of the Permian–Triassic transition from Meishan section, South China: Ecologically assessing mass extinction and its aftermath. Earth-Sci. Rev. 149, 63–103

Guex, J., Galster, F., Hammer, Ø., 2015. Discrete Biochronological Time Scales. 160 pp., Springer.

Henderson, C.M., 2006. Beware of your FO and beware of FAD. Permophiles 47, 8–9.

Jiang, H.S., Lai, X.L., Luo, G.M., Aldridge, R., Zhang, K.X., Wignall, P.B., 2007. Restudy of conodont zonation and evolution across the P/T boundary at Meishan section, Changxing, Zhejiang, China. Global Planet. Change 55, 39–55.

Jiang, H., Lai, X., Yan, C., Aldridge, R. J., Wignall, P., Sun, Y., 2011. Revised conodont zonation and conodont evolution across the Permian–Triassic boundary at the Shangsi section, Guangyuan, Sichuan, South China. Global Planet. Change 77, 103–115.

Jiang, H., Lai, X., Sun, Y., Wignall, P.B., Liu, J., Yan, C., 2014. Permian–Triassic conodonts from Dajiang (Guizhou, South China) and their implication for the age of microbialite deposition in the aftermath of the End-Permian mass extinction. J. Earth Sci. 25, 413–430.

Jiang, H.S., Joachimski, M.M, Wignall, P.B, Zhang, M.H, Lai, X.L, 2015. A delayed end-Permian extinction in deepwater locations and its relationship to temperature trends (Bianyang, Guizhou Province, South China). Palaeogeogr. Palaeoclimat. Palaeoecol. 440, 690–695.

Liu, J.B., Ezaki, Y., Yang, S.R., Wang, H.F., Adachi, N., 2007. Age and sedimentology of microbialites after the end-Permian mass extinction in Luodian, Guizhou Province. J. Palaeogeogr. 9, 473–486 (in Chinese with English abstract).

Perri, M.C., Farabegoli, E., 2003. Conodonts across the Permian–Triassic boundary in the Southern Alps. Courier Forschung Institute of Senckenberg 245, 281–313.

Song, H., Wignall, P. B., Tong, J., Yin, H., 2013. Two pulses of extinction during the Permian–Triassic crisis. Nat. Geosci. 6, 52–56.

Sun, D., Tong, J., Xiong, Y., Tian, L., Yin, H., 2012. Conodont biostratigraphy and evolution across Permian–Triassic boundary at Yangou section, Leping, Jiangxi Province, South China. J. Earth Sci. 23, 311–325.

Wang, L.N., Wignall, P.B., Wang, Y.B., Jiang, H.S., Sun, Y.D., Li, G.S., Yuan, J.L., Lai, X.L., 2016. Depositional conditions and revised age of the Permo–Triassic microbialites at Gaohua section, Cili County (Hunan Province, South China), in press, doi:

10.1016/j.palaeo.2015.11.032

Yin, H.F., Zhang, K.X., Tong, J.N., Yang, Z.Y., Wu, S.B., 2001. The global stratotype section and point (GSSP) of the Permian–Triassic boundary. Episodes 24, 102–114.

Zhang, K., Tong, J., Lai, X., Jiang, H., 2009. Progress on study of conodont sequence for the GSSP section at Meishan, Changxing, Zhejiang Province, South China. Acta Palaeontologica Sinica 48, 474–486 (in Chinese with English abstract).