Devonian–Carboniferous transition in the Pho Han Formation on Cat Ba Island, northeastern Vietnam

Toshifumi Komatsu¹, Reishi Takashima², Hajime Naruse³, Ta Hoa Phuong⁴, Dang Tran Huyen⁵, Nguyen Duc Phong⁶, Dinh Cong Tien⁶, Ho Tien Chung⁶, Tran Tan Van⁶, Satoru Kato⁷, Takumi Mackawa¹ and Yuri Gatovsky⁷

Received January 6, 2012. Accepted April 9, 2012.

¹ Graduate School of Science and Technology, Kumamoto University, Kumamoto 806-8555, Japan

² The Center for Academic Resources and Archives Tohoku University Museum, Tohoku University

³ Graduate School of Science, Kyoto University

⁴ College of Sciences, Vietnam National University

⁵ Vietnam Institute of Geosciences and Mineral Resources (VIGMR)

⁶ Faculty of Science, Kumamoto University

⁷ Geological Faculty, Moscow State University

Corresponding author; T. Komatsu, komatsu@sci.kumamoto-u.ac.jp

The Devonian–Carboniferous Pho Han Formation is exposed on Cat Ba Island—which will soon be designated as a UNESCO Geopark—in Hai Phong Province, Vietnam (Figs. 1, 2). The formation is composed mainly of limestone, shale, and chert, and contains the Devonian–Carboniferous (D–C) boundary (Ta and Doan, 2007). The section that contains the D–C boundary, located in the Cat Co area in southeastern Cat Ba Island, consists mainly of fossiliferous limestone beds intercalated with alternating black organic-rich shales and dark-gray limestone beds (Fig. 3). At this section, Vietnamese paleontologists numbered the limestone and shale beds from 1 to 167.

Ta and Doan (2007) examined the section containing the D–C boundary and reported late Famennian conodont assemblages composed mainly of *Palmatolepis gracilis* and *P. expansa* (e.g., bed 115), and the Early Carboniferous conodont *Siphonodella duplicata* (bed 122), though the basal Carboniferous index conodont *S. sulcata* has never been found at this section.

The carbonates are characterized by a typical turbidite sequence.

Fig. 1. Index map of the studied area. The section that contains the Devonian–Carboniferous boundary is situated at Loc. 01.

Fig. 2. Field photographs of the Devonian–Carboniferous Pho Han Formation in Cat Co, southeastern Cat Ba Island. (A) The Pho Han Formation at Loc. 01, where it is composed mainly of fossiliferous limestone (Dev. L.: Devonian limestone; Carb. L.: Carboniferous limestone) intercalated with alternating black organic-rich shales and dark-gray limestone beds (ABSL), (B) At Loc. 01, the limestone and shale beds are numbered from 1 to 167.

The tops of graded turbidites and hemipelagic marls in beds 1–115 and 129–167 are commonly marked by intense bioturbation, whereas the alternating black shales and dark-gray limestone beds (beds 116–129), which have a total thickness of approximately 90 cm, show no evidence of bioturbation (Fig. 3B). The black shales and dark-gray limestones contain pyrite grains and well-preserved laminations, and may represent an anoxic facies.

The “Hangenberg Anoxic Event” (Latest Famennian to Early Carboniferous) is marked by the accumulation of dark-gray and black shales in many areas of Europe, Africa, China, and North America (Buggisch and Joachimski, 2006). The present study reports a preliminary investigation of the stratigraphy, paleontology, and sedimentology of beds 113–133 in the section on Cat Ba Island that contains the D–C boundary.

Acknowledgment

We gratefully thank Hisayoshi Igo (Institute of Natural History) for useful comments with conodont taxonomy. Ta H. Phuong would like to thank the support from TRIG–A project of VNU Hanoi University of Science.

Fig. 3. (A) Detailed columnar section of alternating black organic-rich shales and dark-gray limestone beds, and the stratigraphic occurrence of the main conodont taxa at Loc. 01. Beds 115 and 122 commonly contain conodonts. The conodont assemblage shows a marked change from bed 115 (Devonian) to bed 122 (Carboniferous), (B) Alternating beds of black organic-rich shales and dark-gray limestone (beds 127–130). The black shales are characterized by well-preserved laminations. Beds 130–131 contain abundant small burrows (white arrows), (C) Conodonts from the Pho Han Formation. a: lateral views, b: lower views, c: upper views. Scale bars = 100 μm. 1. *Palmatolepis expansa* Sandberg and Ziegler from bed 115. 2. *Palmatolepis sigmoidalis* Ziegler from bed 115. 3. *Polygnathus dentatus* Druce from bed 122. 4. *Polygnathus* sp. from bed 160. 5. *Rhodalepis polylophodontiformis* Wang and Yin from bed 115.

References

Buggisch, W. and Joachimski, M. M., 2006, Carbon isotope stratigraphy of the Devonian of Central and Southern Europe. *Palaeogeogr. Palaeoclimatol. Palaeoecol.*, **240**, 68–88.
Ta, H. P. and Doan, N. T., 2007, Discussion on the Devonian/Carboniferous boundary at the south of Cat Ba Island. *Jour. Geol., Ser. A*, **298**, 12–17.