In Search of a Devonian-Carboniferous Boundary

by E. Paproth and M. Stree1

The Working Group on the Devonian-Carboniferous Boundary has reached general agreement on the bio-stratigraphic criteria to be used in identification and correlation of the boundary level. Current work by the Group is now concentrating on the search for a suitable stratotype section in which to formalize the boundary definition.

Introduction

The ICS Working Group on the Devonian-Carboniferous Boundary held its first field meeting in western Europe in 1978. One of the major accomplishments of that meeting was the opportunity to compare, within ten days, depositional environments ranging from "bathyal" to continental, with rates of sedimentation more than one hundred times greater in some areas than in others.

The meeting ended in Courtmacsherry, southern Ireland, where the members concluded that there is already a reasonable degree of correlation of strata near the Devonian-Carboniferous boundary, although refinement is desirable. They decided that the most useful boundary will be one that lies within the span of fully documented, continuous evolution of one or, preferably several groups of fossils. Because of their abundance and tendency toward ubiquitous occurrence, microfossils offer the best practical guidance in selection of a boundary, although megafossils will continue to play an important role. It was also agreed that priority in definition of a boundary is a significant consideration but not a dominant one. The least disruption of the literature is also a desirable objective.

Procedures and Progress 1979 - 1984

During the next meeting of the Working Group in Washington, D.C., in 1979, a more specific proposal was submitted by R. Lane, C.A. Sandberg and W. Ziegler, recommending a particular level to be recognized for working procedures in correlating the Devonian-Carboniferous boundary. Several points were agreed upon by most Working Group members.

In an attempt at close conformity with the current definition of the Devonian-Carboniferous boundary at the base of the Gattendorfia Zone (recommended by the 1935 Heerlen Congress on Carboniferous Stratigraphy), the Working Group recommended a new operational definition of this boundary. This new definition coincides with the first appearance of the conodont Siphonodella sulcata within the evolutionary lineage from Siphonodella praesulcata and immediately precedes the entry of Gattendorfia in the Hönnetal.

The Group also recommended that the lower limits of the Dinantian, Tournaisian, Mississippian, Kinderhookian, and other chronostratigraphic units of similar rank be adjusted to correspond exactly with the proposed placement of the Devonian-Carboniferous boundary at the base of the Siphonodella sulcata Zone.

It was then important to begin the search for a boundary stratotype best displaying this evolutionary lineage, as well as exhibiting adequate representation among other zonally

significant groups. The Working Group has therefore sought information from all interested persons on the location of a boundary stratotype at this level.

In 1980, at a meeting in Paris, sections of Devonian-Carboniferous boundary beds in various regions were demonstrated and discussed. At the end of that meeting, it was resolved to concentrate research for the boundary stratotype in the Rheinisches Schiefergebirge (F.R.G.) and in specific regions of the U.S.S.R.

The Group then visited ten sections of Devonian-Carboniferous boundary beds along the northern border of the Rheinisches Schiefergebirge in 1982. Although boundary beds in these sections seemed to provide the best fossil fauna and microflora then known, none of the sections was suitable to be proposed as a stratotype candidate, either because of evident gaps or other insufficiencies in the successions. Subsequently, more work was carried out particularly in the Hasselbachtal section, which provides the most useful succession yet known of the boundary beds in this region (Becker et al., in Paproth and Stree1, 1984).

Boundary sections in various parts of the U.S.S.R. were described and discussed during a short meeting in Moscow in 1983. Interest was concentrated on two sections in Kazakhstan, at Kija and at Berchogur in the Mugodzhaz mountains of Kazakhstan.

In the same year, a meeting linked to the International Congress on Carboniferous Stratigraphy and Geology (Madrid) originated from a Congress symposium on the Devonian-Carboniferous boundary organized by M. Stree1. On this occasion, the Muhua section of Guizhou Province, China, was described for the first time (Ziegler and Sandberg, in Paproth and Stree1, 1984). It was then agreed "to retain, for the time being, four sections as possible candidate boundary stratotypes: Hasselbachtal (F.R.G.), Kija and Berchogur (U.S.S.R.), and Muhua (China). These sections represent three different fossil environmental conditions." The Kija section was, however, withdrawn from the list shortly afterwards.

Descriptions of the three candidate sections were published in 1984 by Becker, by Barskov, and by Hou and their colleagues in a volume dedicated to critical discussion of the Devonian-Carboniferous boundary (Paproth and Stree1, 1984). However as a result of a further vote at a meeting in Moscow in 1984, it seemed wise to postpone a final vote on the definitive candidate for boundary stratotype, until a "last call for candidate stratotypes" has been answered.

Current Status and Call for Candidates

Since none of the sections at Berchogur, Hasselbachtal and Muhua seems to combine all the characters that are desirable in the stratotype for an international chronostratigraphical boundary, additional proposals are now welcome.

Therefore, detailed descriptions are now invited by the Working Group of any section across Devonian-Carboniferous boundary beds that meets most of the criteria for a stratotype (e.g. Hedberg, 1976, p.24-29 and 83-93; Paproth, 1980; Anon., 1980; Brochwicz-Lewinski, 1980; Paproth and Stree1, in Paproth and Stree1, 1984).

Precise descriptions should include palaeontological, lithological and sedimentological attributes of the section, as well as references to the geological and palaeogeographical framework and the accessibility of the locality. Descriptions should be sent before September 1st, 1987 to the Secretary of the Working Group on the Devonian-Carboniferous Boundary. Two members of the Working Group should have visited that locality.

One of the main requirements of a stratotype section should be the possibility of correlating the boundary level exactly into contemporaneous sediments of other areas and on other continents. For the Devonian-Carboniferous boundary, fossils seem to be the best tools for this correlation, although other methods are used such as geochemistry, geophysics and petrology. In order to minimize possible effects of environmental controls on different fossil groups, recognition of the boundary level should preferably be based on all available faunal and floral data.

The operational definition of the Devonian-Carboniferous boundary is linked to a level near the base of the *Gattendorfia* goniatite Zone, and the level with the oldest representative of the conodont species *Siphonodella sulcata* in an evolutionary lineage. However, it has not yet proved possible to find a section in which specimens of *Siphonodella praesulcata* are followed by transitional *S. praesulcata-sulcata* specimens, followed by *S. sulcata* specimens. Everywhere, there appear to be gaps, at least in the representation of these conodonts.

Fossils of other groups must also therefore be used in the stratigraphical subdivision of the Devonian-Carboniferous boundary beds. Apart from molluscs (cephalopods, bivalves) and other megafaunas, spores have proved to be particularly useful, because they develop rapidly in the critical span of time and are quite common.

Notwithstanding the remaining problem of precise definition, there is good general agreement on the position of the Devonian-Carboniferous boundary. It is possible to locate the precise level of the boundary as defined informally by the Working Group in 1979 in several sections in northern Asia, North America, northern Africa, and in Europe, within a sedimentary interval of less than 5 m to less than 1 m. This suggests considerable refinement of stratigraphical correlation in the boundary beds to a degree that is outstanding for Palaeozoic sediments.

The proposals of the Working Group concerning the biostratigraphic level of the Devonian-Carboniferous boundary appear to be widely applicable and useful. The operational definition of the boundary can be identified in different parts of the globe with a precision that should prove to be acceptable internationally. This does not mean, of course, that one or perhaps more other stratigraphical levels in the uppermost Devonian and lowermost Carboniferous could not be correlated more easily around the globe. But such levels are known only at some distance stratigraphically from the current working level of the Devonian-Carboniferous boundary, in each case a distance considered by the Working Group to be too great. Such horizons are, however, useful in recognizing proximity to the boundary level.

All that we are now lacking for formal definition of the Devonian-Carboniferous Boundary is a boundary stratotype. After a further thorough study this should be selected from the three candidate sections already proposed or from other candidate sections that might be proposed before September 1987.

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