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## Stratigraphic problems: Reference sections, the Tithonian, and the Jurassic/Cretaceous boundary

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**Zusammenfassung:** Der Begriff „Typ-Lokalität“ ist durch den genaueren Begriff „Referenz-Lokalität“ zu ersetzen. Die untere Begrenzung stratigraphischer Einheiten an einer Referenz-Lokalität (Limitotyp oder, besser, Telo-top) wird befürwortet. Am Beispiel des Tithon und der Jura/Kreide-Grenze demonstriert sich die flexible Handhabung stratigraphischer Grenzen.

**Summary:** The term “type locality” has to be replaced. The more exact term “reference locality” is an apt substitute. Limits of stratigraphic units at their bases and at some reference localities are favored (limitotypes, preferably telotopes). Tithonian and the Jurassic/Cretaceous boundary serve to exemplify flexibility in stratigraphic delimitation.

Stratigraphic units may be delimited at their tops and their bases. Rigid fixation of top and base can be achieved at a “type locality”. These limits theoretically present a fossil time vector. To establish time relations these time vectors or rather their limits have to be followed around the globe. This is done by means of biostratigraphy, radiometry, and other less effective methods. Thus theoretical “chronostratigraphy” as advocated by HEDBERG (1961 and other papers) actually depends on rather crude and approximate tools to overcome distance and facies alterations. As a result “chronostratigraphy” with its rigid limits is impracticable.

But for biostratigraphy also rigid fixation has its deficiencies since knowledge of facts is still rather inadequate even in thoroughly studied territories. Consequently it seems inappropriate now to establish limits too firmly (BARTHEL 1964, p. 516).

A ready compromise has been proposed by CALOMON (1965, p. 82). He propagates to delimit the lower boundary of a unit only, at some reference locality (“limitotype”; better telotope –  $\tau\acute{\epsilon}\lambda\omicron\varsigma$  = limit and  $\tau\acute{o}\pi\omicron\varsigma$  = locality). This would allow sufficient liberty for progress in further knowledge.

These boundaries should be chosen at the most complete sections known and within these sections they should be placed at recognizable levels in evolutionary lines of fossils enclosed. Imperfect sections must be avoided.

### Reference Localities:

The term “type locality” is very unfortunate. Preference should be given to the term “reference locality”. This better concept is additionally

offered by the Subcommittee on Stratigraphic Terminology (Congress Norden 1960, pt. 25 [1961], p. 10). "Type localities" are usually found to be anything but typical after prolonged investigation. For this reason the term "type" should be abandoned. In zoological nomenclature a type has but the function of bearing the name and to serve for a pigeonhole of a species. Accordingly a type may shift within a population depending on an author treating the subject at a given time. Nevertheless it sets certain range-limits. "Type" localities should be handled the same way. They are name-bearers and pigeonholes to the respective complementary reference sections which are more complete.

Historic delimitation of a unit at a given reference locality must not prevent subsequent delimitation at a more complete section which then becomes a correlate reference section. Geographic reflexions other than accessibility should not influence selection of such localities.

#### The Tithonian:

Correlate reference sections should be used most appropriately in regions where facies changes impede proper linking of strata. If a correlate reference section eventually proves to be of paramount value its concept may be firmly fitted into the stratigraphic record.

This procedure may be well applicable in the case of the Tithonian. Tithonian is an accepted term for the uppermost Jurassic stage in the Tethyan realm. Tithonian deserves preference to other time — equivalent stages in other faunal provinces, as Portlandian and Volgian, because only within the Tethys world-wide correlation is feasible.

The Tithonian was never given a proper reference section and, so far, it can be correlated with extra-Tethyan provinces at its base and its top only. At the base the Tethyan ammonite *Hybonoticeras hybonotum* (OPPEL) and the para-Tethyan genus *Gravesia* occur jointly in some localities. Above the top the Berriasian *Subthurmannia boissieri* (PICTET) has been found together with the northern index species *Riasanites riasanensis* (LAHUSEN).

Lower and Middle Tithonian substages have been studied now and may be well designated at the northern margins of the Tethys in Bavaria (ZEISS 1968, BARTHEL 1969). Upper Tithonian and Berriasian localities are under investigation in southeastern France by LEHEGARAT & REMANE (1968) and others for possible reference localities.

#### The Jurassic/Cretaceous boundary:

Because the Berriasian ammonite fauna still has a rather Tithonian appearance some early authors included these beds in the Tithonian. General use, however, attached the Berriasian eventually to the Lower Cretaceous.

During the Lyon Colloque sur le Crétacé inférieur 1963 (reports issued 1965) the Berriasian was finally declared as the separate basal stage of the Lower Cretaceous.

Lately, however, once more the dispute has arisen where to draw the Jurassic/Cretaceous boundary. The problem has been reviewed, though in a rather unidirectional manner, by WIEDMANN (1967, 1968) who advocates a boundary above the Berriasian on lithological, faunistic and historical grounds. A boundary placed this way seems very convenient since it is marked in most places by a drastic facies-linked faunal change. But as has become evident recently at some other boundaries, i. e. those between the Permian and the Triassic or the Precambrian and the Cambrian, somewhere on the earth the contrast vanes into transition. These are the spots where "neocatastrophic" and "convenience" sins are being punished. True, it is actually impossible to find a perfect section for reference. But there are many rather complete sections which may be checked against evolutionary progress of apt fossils.

A Jurassic/Cretaceous boundary below the Berriasian as suggested before (BARTHEL 1967) can be controlled by perisphinctid evolutionary lines and by calpionellid assemblages.

This procedure compares readily with the treatment of Callovian/Oxfordian and the Toarcian/Aalenian boundaries. Between these stages the limits are set right into the phylogenetic flux of cardioceratids and Pleydellias.

From the above it becomes apparent that the Jurassic/Cretaceous boundary is best being left at the base of the *Subthurmannia boissieri* zone.

Finally it should be stressed that bases of stages are necessarily the bases of their lowermost biozones. These zone bases should be established at a suitable reference locality, leaving enough allowance for future correction in this telotope.

In many ways we are in full unison with SCHINDEWOLF (1970) and favor his opinion not to establish a selfsupporting set of laws rather than a few simple helpful rules.

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