Permophiles

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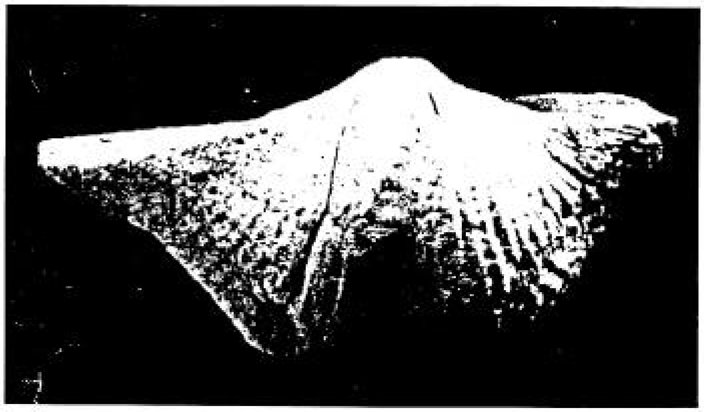

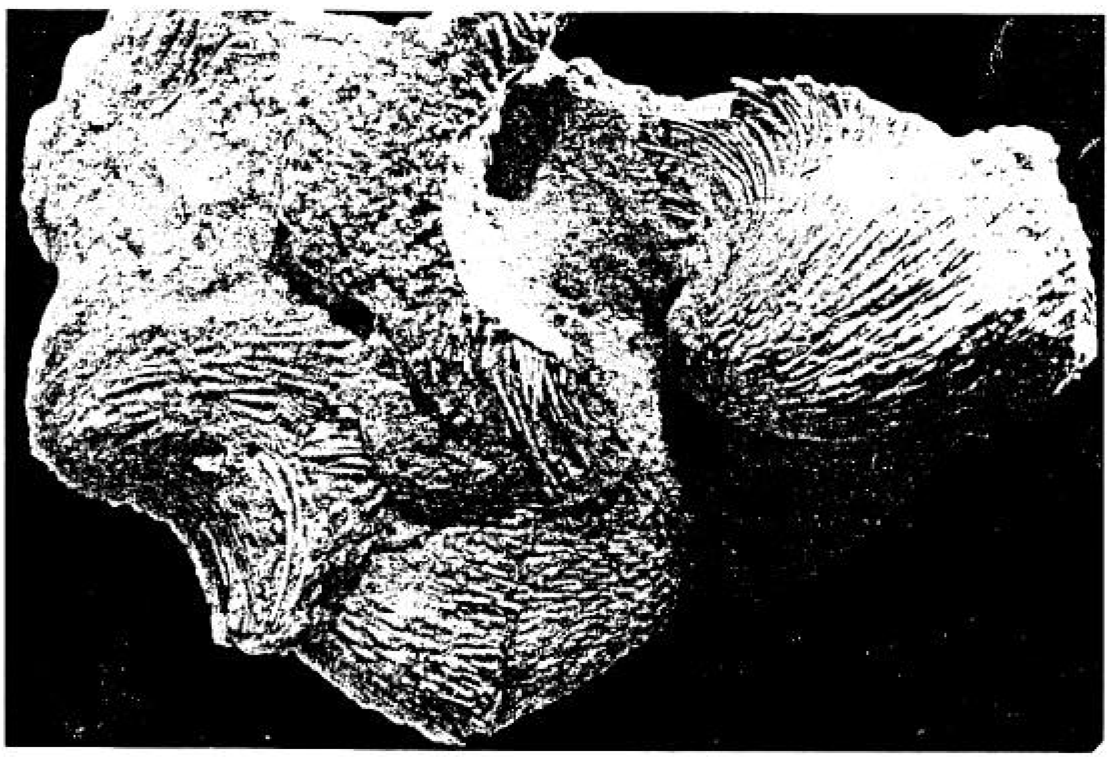

SUBCOMMISSION ON PERMIAN STRATIGRAPHY

INTERNATIONAL COMMISSION ON STRATIGRAPHY

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES (IUGS)

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Top left. Ventral valve of 24 *Subansiria* sp.

Centre. Ventral valves with spines of *Reedoconcha permixta* (Reed). All x 1. From the Saiwan Formation (Late Sakmarian) of the Huqf area, Sultanate of Oman. Photographs provided by L. Angiolini.

1. SECRETARY'S NOTE

I should like to thank all those who contributed to this issue of @Permophiles@. The next issue will be in November 1996 and will be prepared by the new secretary, CIaude Spinosa. Please send your contributions to him (see note below from Forthcoming Secretary).

I should like to express my gratitude to those of you who have submitted contributions during my eight year term of office. You have helped make =Permophiles@ a useful, informative, and timely Newsletter of the Subcommission on Permian Stratigraphy.

J. Utting
Geological Survey of Canada (Calgary)
3303 - 33rd Street N.W.
Calgary, Alberta, Canada T2L 2A7
Phone (404) 292-7093 FAX (403) 292-6014
E-mail INTERNET address: utting@gsc.nrcan.gc.ca

2. ELECTION OF NEW OFFICERS

The results of the recent elections of new officers voted on by the Titular members are as follows.

The new chairman will be Dr. Bruce Wardlaw, and the new Vice-chairmen will be Dr. E. Ya Leven and Dr. Clinton Foster. Dr. Claude Spinosa will be secretary and editor of "Permophiles".

Congratulations to the new slate of officers! They will take up their responsibilities after the 30th International Geological Congress in Beijing in August of this year.

3. NOTE FROM FORTHCOMING SUBCOMMISSION SECRETARY

This note represents the first communication from me as the forthcoming secretary of the Subcommission on Permian Stratigraphy and editor of Permophiles.

First of all, on behalf of the Permian community, I wish to express my appreciation to Dr. John Utting for his work as secretary of the Subcommission and as the editor of an excellent series of Permophiles newsletters; we are indebted to John. My objective is to achieve the same level of excellence.

The next issue of Permophiles is scheduled for November 1996. Everyone is encouraged to submit manuscripts - before October l.

Permophiles will be prepared using WordPerfect 6.1. The preferred method of manuscript submission, therefore, is on IBM computer diskette using WordPerfect 6.1. Hard copies of the text and figures should also accompany the diskette. Files may also be sent in ASCII format or earlier WordPerfect versions. We expect contributions to be submitted as such, but contributions may also be submitted as hard copies (on paper) consisting of text and illustrations as a final resort. Hard copies or FAX versions must be received well before the deadline, as they will require greater processing time. Files can be sent as e-mail attachments; however details should be discussed with Ms. Valencia Garrett, our office coordinator, prior to submission:

Voice: (208) 385-1631; fax (208) 385-4061 e-mail: vgarrett@trex.idbsu.edu

I have discussed the matter of financial support for Permophiles with many of the members of the Permian Subcommission; the consensus is that we should request voluntary donations to offset processing, mailing and paper costs. We are asking for contributions of $10 to $25. However, Permophiles will be mailed to everyone on the mailing list regardless of whether a contribution is made.

We have established access to Permophiles via the Internet; the address will be:

http://earth.idbsu.edu/permian/permophiles

Our intention is to provide a version of Permophiles that is readily available through the Internet. The Internet version of Permophiles will have multiple formats. Initially the format of the Internet version will be different from the official paper version. Because new taxonomic names can not be published in Permophiles, a hard copy, downloaded from the interned will suffice for many of us. Permophiles will also be published as a hard copy version, as has been done in the past; for the purposes of citation, the paper copy will be the only official Permophiles newsletter.

Claude Spinosa Permian Research Institute
Boise State University Boise, Idaho 83725 Phone (208) 385-1581 FAX (208) 385-4061 E-mail cspinosa@trex.idbsu.edu

4. SUBCOMMISSION ON PERMIAN STRATIGRAPHY

Report of the Meeting in Alpine Texas
April 11, 1966 at 2:30 pm.

The following titular members were in attendance: Brian Glenister, Galina Kotlyar, Heinz Kozur, Manfred Menning, Ernst Ya. Leven, Charles A. Ross, Claude Spinosa, Jin Yugan and Bruce Wardlaw,

The meeting was also attended by: Jim W. Adams, Aymon Baud, Vladimir Davydov, William M. Furnish, Dora M. Gallegos, Ernest Gilmour, William Grauton, Tatjana Grunt, James Jones, Lance Lambert, Tatyana B. Leonova, Spencer Lucas, Lewis McNaughton, Don McGookie, Mike Orchard, Shannon Rudine, Rob Stamm, Maureen Steiner, Tim Tozer, and Garner Wilde.

A) COMMENTS BY JIN YUGAN, CHAIR,

SUBCOMIMISSION ON PERMIAN STRATIGRAPHY:

a. REPORT OF ELECTIONS: Bruce R. Wardlaw - Chair Ernst Ya. Leven - First Vice Chair Clinton Foster - Second Vice Chair Claude Spinosa - Secretary. The terms of newly elected officers will begin in August 1996.

b. CARBONIFEROUS-PERMIAN BOUNDARY: The ICS has voted and accepted the proposal, made by the Permian Subcommission, that the Global Boundary Stratotype Section and Point (GSSP) for the base of the Permian System be located at Aidaralash Creek. The proposal will be ratified formally by the IGC at the meeting in Beijing this August.

c. MEMBERSHIP IN THE SUBCOMMISSION: Prof. Wu Wang-shi has resigned and a replacement is being selected. Walter Nassichuk has resigned and will be replaced by Mike Orchard. The Subcommission on Permian Stratigraphy is required to make a **30%** change in membership. Because many existing members are active and because the Subcommission is close to completing recommendations regarding several major boundaries, the subcommission will achieve the required **30%** change in membership by expanding its membership from 16 to 19.

d. INTERNATIONAL GEOLOGIC CONGRESS IN BEIJING - AUGUST 1996: The Subcommission on Permian Stratigraphy will formally meet in Beijing in August during the IGC. There will be a healthy program in paleontology with symposia on Permian stratigraphy, paleobiology and ecology. A poster session, chaired by Brian GIenister, is devoted to biostratigraphy, with emphasis on the Permian and it boundaries.

B) DISCUSSION REGARDING GUADALUPIAN AS THE MIDDLE PERlMIAN SERIES:

a. Developing a formal proposal for a Middle Permian Series - a three-fold division of Permian. A three-fold subdivision is more practical in the view of many American workers.

b. A two-fold division of the Permian - in Russia there is a preference for using a two-fold subdivision.

c. The Guadalupian was proposed formally with series status in 1902; component stages have been utilized as time stntigraphic units since 1961.

d. The need to separate the concept of definition and the concept of con=elation of stratignphic units.

e. Some of the same points raised at this meetings have been raised at various geologic meetings during the last 60 years. It is time to arrive at a consensus.

MOVED BY THE SUBCOMMISSION:

"TO PROCEED WITH ALL APPROPRIATE SPEED TO ESTABLISH THE GUADALUPIAN AS THE MIDDLE PERMIAN SERIES."

THE VOTE BY MEETING PARTICIPANTS WAS: 25 IN FAVOUR, 0 AGAINST, 4 ABSTENTIONS.

C) DISCUSSION REGARDING STAGES OF THE CISURALIAN:

a. The definition of the base of the Asselian at the Aidaralash Creek succession is to be ratified by the IGC at their next meeting in Beijing this August.

b. Use of Kungurian. Most of the comments were in agreement that Kungurian strata in the Urals cannot serve as a time-stratigraphic unit. The term "Kungurian" or "Kungurian-Cathedralian" can be used if Leonard Mountain is utilized as the boundary stratotype.

c. The Kungurian "Formation" is not a good succession to serve as a stratotype for the interval of time between the top of the Artinskian and the base of the Roadian.

d. The Kungurian interval should have the boundary and body stratotype sections at Leonard Mountain.

e. Why use the term "Kungurian" with a stratotype in West Texas?

f. Use "Kungurian-Cathedralian" or "Kungurian (Cathedralian)" or "Cathedralian."

MOVED BY THE SUBCOMMISSION:

"TO ACCEPT THE CISURALIAN SERIES AS COMPOSED OF ASSELIAN, SAKMARIAN, ARTINSKIAN AND KUNGURIAN-CATHEDRALIAN."

THE VOTE BY MEETING PARTICIPANTS WAS: 13 IN FAVOUR, 8 AGAINST, 8 ABSTAINED.

D) DISCUSSION REGARDING THE LOPINGIAN:

a. The Lopingian should be the Upper Permian Series and should be comprised of Laibinian, Wuchiapingian and Changhsingian.

b. The Lopingian should comprise the Laibinian, Wuchiapingian a Changhsingian.

c. The Upper Permian Series should not have a lower division from China, a middle division from Transcaucasia, and an upper division from China. The entire series should be in China.

d. The use of Dzhulfian has long been established and can serve as a time unit. It should be used.

MOVED BY THE SUBCOMMISSION:

"THAT THE LOPINGIAN SERIES BE ACCEPTED AS COMPRISING TWO SUBDIVISIONS: THE LAIBINIAN-WUCHIAPINGIAN AND THE CHANGHSINGIAN."

THE VOTE BY MEETING PARTICIPANTS WAS: 19 IN FAVOUR, 5 OPPOSED, 5 ABSTAINED.

It was suggested that these motions, although not binding, be referred to as the "ALPINE ACCORDS"

A meeting of the Subcommission on Permian Stratigraphy was convened at 6:30 am on April 12, 1996.

The following titular or corresponding members were in attendance:
Aymon Baud
Vladimir Davydov
Brian Glenister
Galina Kotlyar
Heinz Kozur
Manfred Menning
Ernst Ya. Leven
Charles A. Ross
Claude Spinosa
Jin Yugan
Bruce Wardlaw

A) INTRODUCTION BY BRIAN GLENISTER:

The need for this meeting is to send a concise message to Professor Jurgen Remane, Chairman, International Commission on Stratigraphy, that the Subcommission on Permian Stratigraphy is making progress towards arriving at a consensus on major subdivisions of the Permian System. A report must be sent by the Subcommission to Professor Remane regarding the accord achieved in Reston and Florida. The report should present that accord. The draft that was circulated for discussion at Friday's general meeting of Guadalupe II participants was flawed in several respects:

a. It was fundamentally changed from the agreements that were previously reached. For example: There had been previous agreement on three Permian series, the draft showed two.

b. The draft was far too detailed to serve as a report to the ICS.

This morning's meeting is an informal meeting to express the group's conclusions to Professor Remane.

B) DISCUSSION REGARDING USE OF CISURALIAN, GUADALUPIAN, AND LOPINGIAN, WITHOUT THE USE OF LOWER, MIDDLE AND UPPER:

MOVED BY THE SUBCOMMISSION: "EMPLOY THREE PARTS FOR THE PERMIAN B IN THREE REGIONS - CISURALIAN IN THE URALS, GUADALUPIAN IN WEST TEXAS, AND LOPINGIAN IN CHINA. WHEN MORE WORK IS DONE, ADDITIONAL SUBDIVISIONS CAN BE MADE."

THE VOTE WAS:
8 IN FAVOUR, 2 AGAINST, 1 ABSTAINED. (Ayman Baud attended the meeting but did not vote)

C) DISCUSSION REGARDING THE LEVEL OF DETAIL TO BE USED IN THE REPORT TO PROFESSOR REMANE:

a. How detailed should the report be to Professor Remane? Brian Glenister suggested that the level of detail arrived at in Florida is adequate: There were no objections. That level of detail will be used.

D) DISCUSSION - USE OF "KUNGURIAN":

Brian Glenister. The Kungurian will not serve either as body or boundary stratotype. There is agreement that the succession of strata at Leonard Mountain will serve as the stratotype for "Kungurian". Garner Wilde will investigate the possibility of securing formal access to Leonard Mountain. The report to Professor Remane should be from the entire Subcommission.

Other suggestions:
Use "Kungurian/Cathedralian"
Use "Leonardian/Kungurian"
Use "Kungurian-Cathedralian" in Russia and "Cathedralian-Kungurian" in USA
Use "Kungurian" alone
Use "Leonardian" alone

Jin Yugan: Professor Remane needs a simple scale - without details. I will not send him the sheet used for discussion last Friday. We need definition only of bases so we use only Kungurian.

Leven: Agreed with Jin. Names of stages are not politically derived but are of historical and ethical significance and should reflect the work of previous workers. Now we agree that Kungurian, Cathedralian and Bolorian are approximately the same age. Abandon the terms Bolorian and Cathedralian - retain Kungurian.

MOVED BY THE SUBCOMMISSION:
"THE LEVEL OF DETAIL TO INCLUDE IN THE REPORT TO BE SENT TO PROFESSOR REMANE SHOULD BE THE SAME AS SHOWN ON THE CONSENSUS ARRIVED AT IN FLORIDA."
THE VOTE WAS: 8 IN FAVOUR, I OPPOSED, I ABSTENTION.

THE FLORIDA "AGREEMENT"

SERIES	STAGES	POSSIBLE CONODONT IDENTIFIER
LOPINGIAN	CHANGXINGIAN	*C. subcarinata*
	DZHULFIAN	*C. leveni*
	LAIBINIAN	*C. postbitteri*
GUADALUPIAN	CAPITANIAN	*J. postserrata*
	WORDIAN	*J. aserrata*
	ROADIAN	*J. nankingensis*
CISURALIAN	KUNGURIAN	*N. pnevi* *N. exculpus*
	ARTINSKIAN	*Sw. whitei* *S. florensis*
	SAKMARIAN	*Sw. merrilli* *S. barskovi*
	ASSELIAN	*Sw. expansus* *S. isolatus*

MOVED BY THE SUBCOMMISSION:
“TO RECOMMEND THAT THE LOPINGIAN BE USED WITH 2 SUBDIVISIONS AND THAT ALL SUBDIVISIONS BE IN CHINA.”
THE VOTE WAS: 6 IN FAVOUR, 4 AGAINST, 1 ABSTAINED.

MOVED BY THE SUBCOMMISSION:
“THAT THE TERM =KUNGURIAN-LEONARDIAN= BE USED IN PLACE OF =KUNGURIAN= ALONE.”
THE VOTE WAS: 4 IN FAVOUR, 5 AGAINST, 1 ABSTAINED.

Meeting adjourned at 8:30 AM.

5. A GLOBAL CHRONOSTRATIGRAPHIC SCHEME FOR THE PERMIAN SYSTEM TWO DECADES OF THE PERMIAN SUBCOMMSSION

The Permian Subcommission has been attempting for two decades to establish a global time scale for the Permian System and the GSSPs for its initial boundary and intra-systemic boundaries. This has been widely known as a difficult task since that the sequence above the Artinskian of the traditional standard sections in the Urals is virtually useless in intercontinental correlation, and that the available stratigraphic data have long been inadequate in establishing a confident and precise correlation of post-Artinskian successions in strongly differentiated biogeographic regions. We are pleased to see that the conclusion of such a long story to integrate the suitable marine reference successions into a single Permian chronostratigraphic scheme seems now to be approaching.

A generally agreed integrated scheme was achieved through the development of several drafts during the last two decades (Figs. 1, 2).

A. Attempts to build up a composite scheme based on marine sequences as a substitute for the traditional standard were launched in the sixties (Glenister and Furnish, 1961). Subsequently, composite successions integrating various regional stages were proposed based mainly on the interpreted evolutionary succession of regionally limited ammonoid, brachiopod and fusulinid faunas. (Stepanov, 1973; Furnish, 1973; Waterhouse, 1976; Kozur, 1975). However, none of these has gained an overwhelming acceptance because it is often impossible to prove the objective stratigraphic superposition of neighbouring stages. Communications through the newsletters of the Subcommission (Permophiles) led members to realize that it is better to integrate the reference successions from a minimum number of type regions into a standard succession. The scheme suggested by Waterhouse (1982) reflected a momentum brought about by the Subcommission.

B. In 1985 an international committee of the Subcommission was organized. The regional correlation charts worked out by various national working groups in 1987, and discussed in Beijing, showed a considerable consistency in key stratigraphic levels of the marine successions above the Kungurian. In 1988, on behalf of the Subcommission, we recommended Harland and his collaborators to replace the Ufimian, Kazanian and Tatarian stages with the Guadalupian and Lopingian Subseries. They accepted it and considered the introduction of the Lopingian Subseries was a notable novel feature of their new version of the global time scale (1990).

In Perm, Russia, 1991, the succession of Asselian, Sakmarian and Artinskian was further documented as a potentially qualified international standard (Chuvashov et al., 1992), and the Guadalupian Series was formally proposed as a global standard (Glenister et al., 1992). International working groups were organized for erecting the chronostratigraphic successions corresponding respectively with the Lopingian, the Pre-Artinskian and that between the Guadalupian and Artinskian.

C. Leaving aside the widely different usage of the names Early, Middle, and Late Permian, an operational scheme incorporating three most promising reference successions was proposed as a working template for the Permian Subcommission in Guiyang, China, 1994 by its current and past chairpersons (Jin et al., 1994). Updated fossil zones were selected for the scheme. It was following a number of comments, which indicated that among four series recommended, the Uralian and the Lopingian Series are generally acceptable as they are privileged by their historic priority, relatively complete succession and extensive studies. Two middle Permian series, particularly, the Chihsian\the Cathedralian Series in the proposed scheme can not be defined precisely because of the uncertainty in correlation between the Tethyan and the North American successions. More data are desirable to establish this unit.

D. During the International Guadalupian Symposium II (IGS II) in Alpine of U.S.A. this April, the Working Group on Post-Artinskian Series suggested to retain the name of the Kungurian Stage in the scheme and to define its initiation at the base of the *Neostreptognathodus pnevi - N. exsculptus* Zone with the understanding that this stage should be established based on full marine successions in North America or in Tethys because of the lack of normal marine succession of the Kungurian in its eponymous area. At the Subcommission’s meeting, this proposal was accepted by all Titular Members and the usage of the Cisuralian Series and its subdivisions, namely, the Asselian, the Sakmarian, Artinskian and the Kungurian Stage was passed by voting. An emendation to use “the Kungurian Stage\the Cathedralian Stage” as the substitute of “the Kungurian Stage” has been put forwarded by some Titular Members but did not gain a majority of votes.

At this meeting, the usage of the Lopingian Series and its two subdivisions, namely, the Wuchiapingian and the Changhsingian Stage for the uppermost series of the Per-

Present scheme				Jin et al., 1994		Harland et al., 1989			Waterhouse, 1982	
	Series	Stages	Basal conodont zone							
PERMIAN	Lopingian	Changhsingian	*Clarkina subcarinata*	Lopingian	Changhsingian	Zechstein	Lopingian	Changhsingian	Lopingian	Changhsingian
		Wuchiapingian	*Clarkina postbitteri*		Dzhulfian (Wuchiapingian)			Lungtanian		Lungtanian
	Guadalupian	Capitanian	*Jinogondolella postaserrata*	Guadalupian	Capitanian		Guadalupian	Capitanian	Guadalupian	Capitanian
		Wordian	*Jinogondolella aserrata*		Wordian			Wordian		Wordian
		Roadian	*Jinogondolella nankingensis*		Roadian			Ufimian		Roadian
	Cisuralian	Kungurian	*Neostreptognathodus pnevi- N. exculptus*	Chihsian (Cathedralian)	Kubergandinian Bolorian	Rotliegendes		Kungurian		
		Artinskian	*Sweetognathus whitei- Mesogondolella bisselli*	Uralian	Artinskian			Artinskian	Cisuralian	Baigendzinian
		Sakmarian	*Streptognathodus postfusus*		Sakmarian			Sakmarian		Sakmarian
		Asselian	*Streptognathodus isolatus*		Asselian			Asselian		Asselian

Figure 1.

SERIES		STAGES	SELECTED FOSSIL ZONES: Ammonoids	Conodonts	Fusulinids	Polarity
Triassic		Griesbachian	*Ophiceras* *Otoceras*	*Hindeodus parvus*		
PERMIAN	Lopingian	Chang-hsingian	*Pseudotirolites* *Paratirolites - Shevyrevites* *Iranites- Phisonites*	*Clarkina changxing-ensis* *C. subcarinata*	*Palaeofusulina sinensis*	
		Wuchia-pingian	*Araxoceras-Konglingites* *Anderssonoceras* *Roadoceras-Doulingoceras*	*C. orientalis* *C. leveni* *C. dukouensis* *C. postbitteri*	*Nanlingella simplex-* *Codonofusiella kwangsiana*	
	Guadalupian	Capitanian	*Timorites*	*Jinogondolella altudaensis* *J. postserrata*	*Lepidolina* *Yabeina* *Polydiexodina shumardi*	
		Wordian	*Waagenoceras*	*J. asserata*	*Neoschwagerina craticalifera*	
		Roadian	*Demaretzites* *Stacheoceras discoedale*	*J. nankingensis*	*Praesumatrina neoschwagerinoides* *Cancellina cutalensis-Armenina*	Illawarra Riversal
	Cisuralian	Kungurian	*Pseudovidrioceras dunbari* *Propinacoceras busterense*	*Mesogondolella idahoensis* *Neostreptognathodus pnevi-* *N. exculptus*	*Misellina claudiae* *Brevaxina dyhrenfurthi*	
		Artinskian	*Uraloceras fedorowi* *Aktubinskia notabilis-* *Artinskia artiensis*	*N. pequopensis* *Sweetognathus whitei-* *M. bisselli*	*Pamirina* *Charaloschwagerina valgaris*	
		Sakmarian	*Sakmarites inflatus* *Svetlanoceras strigosum*	*S. primus* *Streptognathodus postfusus*	*Robustoschwagerina schellwieni* *Sphaeroschwagerina sphaerica-*	
		Asselian	*S. serpentinum* *S. primore*	*S. constrictus* *S. isolatus*	*S. moelleri- P. fecunda* *S. vulgaris*	
Carboni-ferous		Gzhelian	*Shumardites confessus-* *Emilites plummeri*	*S. wabaunsensis* *S. elongatus*	*Daixina robusta-* *D. bosbytauensis* *T. stuckenbergi*	

Figure 2.

mian System, and the Guadalupian Series and its subdivisions, namely, the Roadian, the Wordian and the Capitanian Stage for the middle series of the Permian System was also passed by voting.

E. With regard to the basal boundary of this system, the Working Group on the Carboniferous\Permian boundary was re-organized in Beijing, 1987. Two years later, the potential stratigraphic levels for the OP boundary were narrowed down to two horizons at a meeting of the WGCP during the 28th IGC in Washington D.C. A proposal to define the Carboniferous-Permian boundary at Aidaralash Creek, Northern Kazakhstan **was** passed in the Subcommission and the Commission on Stratigraphy in 1995, and now has been ratified by the executive board of IUGS. It is marked by the first appearance of *Streptognathodus isolatus.* The boundary level is located within the Bed 19, slightly below the boundary between the *Shumardites-Vidrioceras* and the *Svetlanoceras-Juresanites* Genozone, and approximately coincides with the base of *Sphaeroschwagerina vulgaris - S. fusiformis* Zone.

The steady progress in developing an integrated scheme during the last two decades reveals that it is an international program with increasing support from the members of the Subcommission but should not be understood as a recent event favoured only by part members (Grunt, 1995). It also proves the strength of an improved succession of conodont zones which can provide a sound biostratigraphic basis in establishing an integrated scheme, and the evolutionary clines of conodont claudes are able to provide with the best biostratigraphic criteria in defining the GSSPs of the intra-systemic boundaries.

Many parts of the conodont succession need urgently to be elaborated, classification of the leading taxa of conodonts should be clarified based on well represented samples, correlation between the successions of conodonts and other leading fossils should be erected as much as we can, and so forth. Nevertheless, all of these implies merely that we need to invest more in this framework.

Notes on the present scheme

A. 7he Cisuralian Series: The name was proposed by Waterhouse (1982) to denote an interval from the Asselian, the Sakmarian to the Artinskian, but in the present scheme, it also comprises the Kungurian, and therefore, corresponding to the Lower Permian of a largely Russian schemes for the Permian (Licharev, 1966; Kotlyar, 1984), and the Rotliegendes of Harland et al. (1990). The name of the Uralian Series employed by Jin et al. (1994) which has been used to denote various time interval, and the Yukian Series newly recommended by Leven (1994) are both not accepted.

The time span of this series is relatively longer than the other two, and the eustatic and biotic changes within the Artinskian are remarkable. Consequently, there is a potential to divide this series into two independent series or two subseries, of which the upper one is approximately an equivalent of the Chihsian\the Cathedralian Series of the preceding scheme (Jin et al., 1994).

Definitions of the constituent stages are suggested as follows based on the biostratigraphic successions of their eponymous areas. The initial Sakmarian Stage boundary lies at the base of the *Streptognathodus postfusus* in the Shihanskian Horizon. The initial Artinskian Stage boundary lies at the base of the *Sweetognathus whitei* Zone within the Bursevsk Horizon Formation. The initial Kungurian Stage boundary lies at the base of the *Neostreptognathodus pnevi* Zone at the base of the Saraninsk Horizon (Chuvashov, 1991). The corresponding conodont zones in Tethyan and North American successions are dominated by *N. exsculptus*. Of course, the stages will be defined at the boundary stratotype, but it is not yet clear where the GSSP will be.

B. The Guadalupian Series It has been decided to standardize this series and its constituent stages according to the biostratigraphic sequence in West Texas and New Mexico. The basal level of the Guadalupian Series is proposed to be indicated by the first appearance of *Jinogondolella nankingensis* within an evolutionary cline from *Mesogondolella idahoensis* to *J. nankingensis* in the El Centro Member of the Cutoff Formation.

So far as I understand, its corresponding zone of other fossil groups can not be directly fixed in its proposed type section. Moreover, this level has not yet been recognized in Tethyan successions. In South China, the lowest level of *J. nankingensis* known is the *Praesumatrina neoschwagerinoides* Zone, but the Roadian ammonoid fauna is said to be found from the *Cancellina cutalensis* Zone (Bogoslovskaya, 1994). The proposed initial boundary of the Wordian and the Capitanian Stage is respectively indicated by the earliest occurrence of *J. aserrata* within the Gateway Limestone Member of the Brushy Canyon Formation and that of *J. posraserrata* within the Pinery Member of the Bell Canyon Formation.

C. The Lopingian Series: Establishment of a complete succession of conodont zones from the Capitanian Stage to the Wuchiapingian Stage of Lopingian Series strengthened the international momentum to use the Lopingian Series and its constituent stages as the international standard for the last series of the Permian System. It is suggested to place the initial boundary of this series at the base of the *Clarkina postbitteri* Zone. The initial boundary of the Changhsingian Stage lies at the base of the *Clarkina subcarinata* Zone within the Changhsing Formation.

Because of priority of the Dzhulfian Stage over the Wuchiapingian Stage, attempt has been made to replace the Wuchiapingian Stage with two stages, namely the Laibinian Stage in the lower part and the Dzhulfian Stage in the upper, for the latter the initial boundary is changed to the base of the *Cl. leveni* Zone. This suggestion was put forward in order to define the stratotype of the Dzhulfian Stage in South China. The Permian Subcommission agreed to take the advantages of integrating the type regions as simple as possible, and therefore, declined to keep the name of the Dzhulfian Stage. The Arctic-Gondwana counterparts of the Lopingian deposits in Tethys has long been in confusion. Re-study on the Permian conodonts from the Salt Range by Dr. Wardlaw proves that *Clarkina dukouensis* Mei and Wardlaw of early Wuchiapingian Stage appears in the upper part of the Wargal Formation. This fact confirms a Lopingian age of the *Cyclolobus* fauna, which was widely found in the uppermost part of Permian successions in Arctic and Gondwana.

D. The Permian magnetostratigraphic sequence has been revised recently by Menning (1993). He pointed out that the Carboniferous-Permian Reversed Megazone (CPRM) comprises 5 normal zones, and the Permian part of the Permian-Triassic Mixed Megazone (PTMM) may comprise more than 15 normal zones. A correlation chart of the PTMM sequences made by Steiner (unpub., 1996) indicates that most normal zones can be recognized internationally. According to Dr. Haller and his collaborators, the Illawarra Reversal (IR) occurred in the upper part of the Maokou Formation in South China and the Lower part of the Wargal Formation in the Salt Range, which correspond with the *Neoschwagerina margaritae* Zone and the *Jinogondolella aserrara* Zone of the Wordian Stage. There are two or possibly three normal zones in the late Guadalupian Series. The Wuchiapingian Stage contains two normal zones in its lower part, and one upper in the Salt Range and South China. At the Meishan Section, the Changhsingian Stage comprises a normal zone at the base, at least three mixed zones in the lower part, a normal zone in the upper and a reversal near the top. Dr. M. Menning is now working with us on defining the accurate level of the IR, the base of PTMM in South China. He predicts that the IR should be within the Wordian Stage.

E. The isotopic age of Permian boundaries is now under an overall re-study on the ash beds with fine biostratigraphic control by several labs. An age of 250 Ma for the Permian - Triassic boundary clay bed of the Meishan Section, South China has been confirmed recently. Dr. J. C. Claoue-Long reported in the 13th Carboniferous-Permian Congress last year the dating of samples from the Urals. The age of the Upper Asselian is 290 Ma, and that of the Sakmarian/ Artinskian boundary is 280 Ma

Conclusions

The real strength of a general scheme is its potential in correlation. This integrated scheme enable us to correlate the Permian marine sequences over all the world with higher resolution than previously. Since the Permian was a period characterized by the consolidation and the zenith of Pangea, Permian deposits of Pangea are typified by the succession in the Urals in various extent and thus, the traditional standard succession would be useful in correlation between these depositional successions (Kotlyar, 1995). An attempt to erect the correlation between the proposed standard and the continental succession, which will be undertaken by an international working group headed by Drs. Lozovsky and Schneider, is highly important for getting an overall view of Permian correlation.

Potentiality of correlation is also a basic requirement of an acceptable stratigraphic boundary level as well as the GSSP. In this regard, the proposed stratigraphic levels of intra-systemic boundaries in this scheme are open for careful testing in the areas away from the type section to see if it is workable. For selecting a GSSP, a handful of candidate sections would be much better than a single candidate section. Members of the Subcommission are encouraged to recommend the candidate sections of the basal GSSPs of Permian stages and series.

For speeding up the completion of the Subcommission's task, I would like to emphasize again 'the greatest expectation' when I conclude my terms of chairmanship, that is, 'the substantial contributions to be made in improving the international correlation of Permian sequences and the minimization of geopolitical influence that would cloud the issue.' (Jin et al., 1994).

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Jin Yugan Nanjing
Institute of Geology and Palaeontology, China

6. MIDDLE PERMIAN STRATOTYPE

Regarding selection of the Middle Permian Stratotype, I would like to refer to the Permophiles No. 27, November 1995, page 5 - item 6 (Field work on the Lopingian Stratigraphy in Iran).

Jin Yugan and Zhu Zili of the Nanjing Institute of Geology and Paleontology visited the Abadeh section Central Iran in may 1995 and write that (the Guadalupian and the Lopingian sequences were fully developed, and there is no obvious sedimentary evidence of depositional gap between the sequences of these two epochs, ...). This statement supports my previous statement that the Abadeh section in Central Iran, which is located in the central part of the Tethys, contains a complete marine geologic sequence from Artinskian to Dzhulfian, which can serve as the Middle Permian Stratotype.

Detailed paleontological study of this section, especially the lower part of Unit 1 should be done in cooperation with the Geological Survey of Iran sometime in the future. I invite authorities to concentrate on this study, and cooperate with the Geological Survey of Iran for this purpose.

Hooshang Taraz, PhD.
Nicholls State University
Thibodaux, LA U.S.A.

7. A SUCCESSOR PROJECT FOR IGCP 328: PALAEOZOIC MICROVERTEBRATES?

Following on from the success of IGCP 328 (see 1995 publication listing in Turner ed. 1995 Ichthyolith Issues no. 16) and the proposal by Schneider et al. for a new SCPS project on "The Continental Permian of the World" (see Permophiles no. 26), workers particularly in the Late Carboniferous to Triassic are preparing a proposal for a successor project to examine "Late Palaeozoic/ Mesozoic Vertebrate Biostratigraphy of Pangea and global marine-nonmarine correlation" with emphasis on preparing microvertebrate standard zones for the Carboniferous, Permian and Triassic and examining their relationship to conodont, palynological and invertebrat
e zonations.

Work carried out already by IGCP 328 indicates the importance of xenacanth and hybodont shark teeth as useful zone fossils throughout this time span. These fishes can be found in marine, marginal marine and freshwater deposits. The principal proposers will include Professor J F6rg Schneider (Germany), Dr. Georges Gand (France), Dr. Spencer Lucas (USA) and Dr. S. Turner (Australia)
.

Background and objectives: Late Palaeozoic and early Mesozoic continental clastics and marine shelf carbonates are important source rocks (coals, black shales), as well as reservoir rocks (sandstones, carbonate buildups, oolitic grainstones), for fossil fuels, especially gas and oil. This time period covers the formation and the start of the break up of the Pangea Supercontinent (transition from the Variscian (Hercynian) to the Alpidic Geotectonic Supercycle) as well as the transition from the late Carboniferous/early Permian glaciation via late Permian aridisation to the late Mesozoic greenhouse. It covers the Permian/Triassic mass extinction as well as the following recovery and radiation of marine and continental vertebrates. For practical purposes, e.g. the exploration of coal, gas and oil, as well as for understanding of global climatic and environmental changes, and biotic and geotectonic events, we need an exact time control which has been missing up to now. Therefore, the main goal of the project is integration of the results of basic research with the large amount of data from practical research of fossil fuel exploration. From this we shall develop new biostratigraphic tools using macro- and microvertebrate:, arthropods, palynomorphs, to solve the problems of local (intrabasinal; drilling cores, X-ray curves), interregional to global correlation of nonmarine, transitional continental-marine and marine rocks. We shall also produce a synthesis and calibration of the biostratigraphic data with magnetostratigraphic scales, isotopic ages and sea level curves of late Palaeozoic to (Early)
Mesozoic time.

Work in progress: Within IGCP 328 we already have a network of committed vertebrate workers on Late Palaeozoic fishes as well as interested parties in Mesozoic research and tetrapod workers. Also in touch with the project are a number of geologists (conodont workers, palynologists, paleobotanists etc.) who have supported IGCP 328. The newsletter Ichthyolith Issues (editor Dr. S. Turner) acts as an anchor, disseminator of information, news and ideas for the working groups. Work plan: A possible 1996 workshop connected with field work in the Donezk basin of the Ukraine. This area offers a complete section ranging from mixed marine/ continental Devonian up to the Lower Permian Asselian marine and continental deposits, the Gzhelian/Asselian boundary section (the proposed Carboniferous/Permian boundary) containing marine and lacustrine limestones, rich in ichthyoliths as well as black shales with arthropods, plant remains and palynomorphs.

Russian-German co-operation on this project has already been planned. V. Lozovsky (Geological Prospecting, Russia) and Schneider have already proposed "The Continental Permian of the World" (see Permophiles no. 26); in the Bruxiere basin of France, where there are uranium quarries, very rich in fishes and amphibians, an France/German project for scientific cooperation is in progress together with Georges Gand and Jan Marc Poulin; with Jean-Claude Gall (Europal), Schneider has discussed a European scientific network on Fossil Insects from which we could expect substantial input to our new project. Individual work in progress on Carboniferous, Permian and Mesozoic vertebrates and related matters are recorded in Ichthyolith Issues. Schneider has already a new insect/conchostracan range chart (base Westphalian up to the Tatarian/Midian) prepared for German gas companies and am working on drill cores of Permian marine carbonates, doing microfacies analysis for oil exploration. New work on Carboniferous and Permian/Triassic fishes is initiated in Australia, South America and South Africa as well as in classic regions in the northern hemisphere such as those in the U.K. and U.S.A. and new areas including British Columbia of Canada.
If accepted by the UNESCO/I.U.G.S. scientific committee the first meeting of the new project will be held in mid 1997 at the 2nd Mesozoic Fishes meeting in Berlin (co-organizers Pr. Dr. H.-P. Schultze and Dr. G. Arratia).

Work of the IPA International Microvertebrate group has been motivated over the past five years by the aims and objectives of

IGCP 328: Palaeozoic Microvertebrates and especially the need for marine-nonmarine correlation. 1996 is a year on extended term for 328 and a final report is being produced which is destined for CFS. International co- operation is planned between Prof. G.D. Johnson and Dr. P. Murry (USA) and Wang N-Z and Prof. Liao Zhuoting (China) to study the Permian fishes of the Turpan Basin, Xinjiang and Anhui Province. Johnson is also working on Lower Permian microvertebrates of the southwestern USA (Texas, Oklahoma) and their potential for correlation. Renewed work on the Permian fishes of central Europe (Hampe, Heidtke and Schneider in Saar-Nahe and Saxony, Germany; Stamberg and Zajic in the Krkonose Basin, Czechia) has led to greater understanding and use of xenacanth and hybodont teeth for biocorrelation. New Permian vertebrate sites have been found in NSW, Australia and Brazil.

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Dr. Susan Turner – Australian Research Fellow,
Co-Leader IGCP 328
Queensland Museum
P.O. Box 3300 South Brisbane, Queensland 4101
Ph: 61 7 3840 7677 Fx: 61 7 3846 1918

8. A SUMMARY OF FLORAL DISTRIBLTION IN THE PERVIIAV GONDWANA SEQUEVCE OF INDIA

The Permian sequence of India, commonly referred to as the Lower Gondwana, is divided into Talchir, Karharbari, Barakar, Barren Measures and Raniganj formations. The sequences are well represented in different basins of Peninsular India e.g. Damodar, Koel, Son-Mahanadi and Pranhita-Godavari. Plant fossil assemblages are recorded from almost all the formations of these basins.

The flora known as the *Glossopteris* flora due to presence of glossopterid leaves shows the classic similarity with the Gondwana flora of other southern hemispheric continents i.e. Australia, Antarctica, South America and southern Africa. However, it indicates a distinct pattern in having characteristic association at different stratigraphic level in India.

The earliest stage, i.e. Talchir Formation, in all likelihood contains the early stage of the flora, is commonly known by the leaves of *Gangamopteris* and *Noeggerathiopsis*. Other elements are recorded by a fewer number of specimens (Chandra et al., 1992). The flora from the Karharbari Formation shows diversity and proliferation of the *Gangamopteris - Noeggerathiopsis* association together with the characteristic elements of its own e.g. *Botrychiopsis*, *Buriadia*, *Euryphyllum* and *Rubidgea* (Lele, 1976). The successive younger horizon, the Barakar Formation is marked by the presence of two floral zones. The assemblages of the lower Barakar indicate the continuation of the older flora of the Karharbari Formation i.e. *Gangamopteris - Noeggerathiopsis* complex but lack the presence of other forms. The plant fossils from the Upper Barakar demonstrate the complete elimination of the earlier flora and show the dominance of *Glossopteris* leaves (Srivastava, 1992). Quite often sterile foliage frond of *Neomariopteris* is associated with the flora. The fossil assemblage from the Barren Measures is inadequately known and exhibits the similarity with the flora of Upper Barakar in having frequent occurrence of *Glossopteris* spp., but presence of the lycopsid genus, *Lycopodiopsis (=Cyclodendron)* makes the flora distinct (Surange, 1975). Raniganj Formation representing the Upper limit of Permian shows the greatest diversity of the flora both in quality as well as in quantity. The maximum number of *Glossopteris* species (about 50), glossopterid fructification (10), filicales (8), equisetales (4), sphenophylls (2) and number of seeds and sporangia are known from this formation (Srivastava, 1986). Thus the glossopterid-pteridophyte association marks the end of the Permian Gondwana flora of India.

The floral change at different stratigraphic levels of the Permian Gondwana of India suggests that after the early stage of the *Glossopteris* flora in the Talchir Formation the flora acquired major shift at three levels. Dominance of *Gangamopteris-Noeggerathiopsis* and appearance of newer forms in the Karharbari Formation marked the first breakthrough, the extinction of older forms and dominance of *Glossopteris* spp. during Upper Barakar signifies a diversion of the flora from gangarnopteroid phase to glossopteroid phase, the third and final level of change is visible in the Raniganj Formation where the flora flourished with many new types of glossopterid leaves, fructifications, sterile and fertile fronds of pteridophytes, seeds and sporangia in abundance.

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A.K. Srivastava
Birbal Sahni Institute of Palaeobotany
53, University Road, Lucknow-226007
INDIA

9. THE SIGNIFICANCE OF EXINE STRUCTURES IN THE GENE-POOL OF SACCATE POLLEN FOR THEIR REAL IDENTITY

An extensive microscopic observation in saccate pollen has been made by us to study the intricate nature of exine structure on central body surface. For this objective the monosaccate as well as bisaccate pollen in Permian and Triassic sequences in Europe and Indian peninsula have been observed.

It includes several type materials from Europe and India (Leschik, 1956; Schaarschmidt, 1963; Madler, 1964; Klaus, 1960, 1963, 1964; Potonié and Klaus, 1954; Scheuring, 1970; Playford and Dettmann, 1965; Sinha, 1972; Bharadwaj and Tiwari, 1977; Tiwari and Rana, 1980) by the authors for the research paper entitled – Differential morphographic identity of Gondwanic palynomorphs in *Palaeobotanist 44:* 62-115, to expedite the real *vis-a-vis* apparent form similarity among the bisaccate pollen taxa of two hemispheres during the same time span. The basis, formulated for discussion in morphogaphy are – exine structures, cappa, saccus and organization.

More emphasis is laid on to the exine structures. The Gondwana pollen exhibit mostly microreticulate structure constituted by perfect muri and meshes. Thus, there are three main patterns of exine structures in Gondwana pollen – (1) perfectly infrareticulum. (2) rarely infrapunctation, and (3) microverrucose sculpture.

But in several of striate, taeniate and non-striate saccate pollen groups from Euromerican Permian and Triassic have basically different lines of structure pattern. The infrastructure of exine, is given here a new term *infravermiplexate*, it consists of variably shaped island-like elements, vermiculate, ridge shaped imparting a look of a drainage system. The infravermiplexate structure of exine is not at all typical “reticulate network”.

This study revealed real differences in similar looking pollen forms in differential development of sexine on the proximal face of the central body and saccus covering on to the body. In addition, the bisaccate pollen taxa of Permian and Triassic Gondwana assemblages in India, which were described under *Lunatisporites*, *Lueckisporites* and *Klausipollenites*, have now been given new names to differentiate them from northern taxa.

l. *Arcuatipollenites* Tiwari and Vijaya 1995
2. *Dicappipollenites* Tiwari and Vijaya 1995
3. *Krempipollenites* Tiwari and Vijaya 1995

Beside the taxonomic assignment, on the basis of valuable observations of certain type specimens, comments on some important taxa – *Kraeuselisporites, Cordaitina, Hexasaccites, Crucisaccites, Sulcatisporites, Falcisporites, Crescentipollenites, Chordasporites* have also been given to provide more insight in real *vis-a-vis* apparent from similarity.

Differential morphographic flows in palynofloral structuring of Euromerican and Indian Gondwana palynofloras, which had resulted due to latitudinal disparity, have been discussed in this paper.

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Vijaya
Assistant Director
Birbal Sahni Institute of Palaeobotany
Lucknow

10. ”DCB” - A GOLDEN JUBILEE TRIBUTE

The Birbal Sahni Institute of Palaeobotany is running in the Golden Jubilee Year with a fruitful history of the past 49 years. The palaeobotanical research has covered various aspects, viz., early life, origin, radiation and decline of the *Glossopteris* flora, exploration of fossil fuels, affinities and genetic relationships of Paleozoic and Mesozoic floras of the Himalaya region with a global perspective on continental drift, evolution and diversification of Tertiary floras of India with emphasis on the spread of Angiosperms, Pre- and Protohistoric culture, biopetrological assessment of coals and lignites, reconstruction of phytogeographic and palaeoclimatic models for the Quaternary, vegetational dynamics and conservation of forests, geochronometry, palaeobiochemistry, and geobotany.

The results of this research are published in Indian and Foreign Journals. The growth of any organization is reflected in the increase of the strength of the staff and the number of publications, The growth of the Institute shows total strength to be one hundred ninety-six in March 1995. The publication of the institute records 43 volumes of the Journal, The Palaeobotanist, special publications including monographs, books, catalogues, annotated synopsis and hundreds of research papers by the scientists. The increasing number of publications has given a thought for the use of computer in the data handling. At present most of the leading organizations have developed their own Data Bank in their specific field. The use of the computer reflects the twenty-first century to be the century of computers. In the Birbal Sahni Institute, Dr. D.C. Bharadwaj, ex-deputy Director, realized the need for computers since the late 1970s. He initiated the cataloguing of references pertaining to palynological studies of Indian Gondwana sediments and allied aspects being done at the Department of Pre-Gondwana and Gondwana Palynostratigaphy (PGGP) since 1973. This provided a way to use the computer in palynology. The plan of developing the Data Bank pertaining to the objective of the catalogue became true. Under able guidance of Dr. R.S. Tiwari, Director, BSIP, the team of palynologists - Suresh C. Srivastava, Archana Tripathi, Pramod Kumar, Vijaya, B.N. Jana, Ram-Awatar, K.L. Meena and A.P. Bhattacharyya working in the Department of PGGP at BSIP have developed a Data Bank in dBASE III P!us Software. The work started with the development of a computer program (Rajagopalan, Tiwari, Srivastava, Tripathi and Singh, 1984) for storage and retrieval of palynological references. The program was coded in Business Basin (BBASIC) language provided by UPTRON Digital System Ltd. for the S-810 microcomputer, with the technical expertise of Dr. G. Rajagopalan, Deputy Director, Birbal Sahni Institute of Palaeobotany, Lucknow.

With new aid of the IBM Computer – Microsoft Computer 8088 PC/XT the data is now available in dBASE III Plus software. The data field records about 2000 references on the subject concerned. For the effective and purposeful utilization the search retrieval of data was felt necessary. With this objective it was planned to develop a programme to retrieve the references according to the fields identified for a record. This field could be an author, year, area, basin, a e and various subjects, e.g., palynostratigraphy, morphotaxonomy, electronmicroscopy, palynological techniques, palaeoclimate, boundary problems, geology, stratigraphy, etc. Hence a computer-aided program has been developed by R.S. Tiwari. Arachana Tripathi and R. Nandhgopal at the Birbal Sahni Institute of Palaeobotany, in a microcomputer – SOSS, PC,'XT. This program is coded in dBASE III Plus Data Base Software. The program is classified in various retrieval options. The options could be for one field or combination of more than one fields. This program has been named "DCB" in memory of the late Dr. Dinesh Chandra Bhandwaj, Ex-Deputy Director, Birbal Shani Institute of Palaeobotany, India who initiated the palaeopalynological researches with the identification of Gondwanic palynomorphs.

Archana Tripathi
Birbal Sahni Institute of Palaeobotany
Lucknow, India

11. PALYNOSTRATIGRAPHIC STUDIES IN LATE- PALAEOZOIC AND MESOZOIC SEQUENCES IN NITI AND SPITI AREAS OF TETHYS HIMALAYAS

Recovery of spores-pollen in the tectonically effected sediments of Tethys Himalaya is a very difficult task. The preservation of palynomorphs, because of taphonomic factors, is not good enough to be utilized in morphotaxonomy. However, during recent years efforts have been made towards the palynostratigraphic studies in this region, and satisfactory results could be achieved.

With this objective, the Late Permian, Early Triassic and Late Jurassic sequences have been worked out in about eight sections – Niti Pass, Hoti Gad, Shal Shal Nala, Raulibagar, Rambakot and Lapthal, of the Niti area.

Successional palynosequence representing Permo-Triassic boundary transition is recovered in the Hoti Gad Section. Similar record of the Jurassic palynoassemblage in Spiti Member of Lapthal section is significant.

The palynoassemblages recovered in Tethyan sequence of Niti area have been assessed for their qualitative composition, and arc being tagged with well-established palynosequence on Indian peninsula. In totality, a general trend of similarity is revealed between the palynofloras of the two regions. The age of non-marine Permian-Triassic sequences has also been evaluated in the Niti area.

The manuscript is in press and will be published in *Review of Palaeobotany and Palynology*, by R.S. Tiwari, Vijaya, B.D. Mamgain and R.S. Misra.

In the Spiti area, the Permian and Early Triassic Tethyan sequences have been investigated for their palynostratigraphy. These include – Takcha section, Mandaksa section, and Ganmachidam Hill Section in the Upper Spiti Valley and Poh Hillock section in the Lower Spiti Valley. The taphonomic observations of palynomorphs reflect high diagenetic activity within the sediments.

The Permian sequence is represented in the Mandaksa Nala, Ganmachidam Hill. Lingti Road and Lingti Hill sections (Ganmachidam, Gechang and Gungri formations) and has yielded – *Densipollenites*, *Faunipollenites* and *Crescentipollenites*. On the basis of varied relative frequency of these taxa, Barakar and Raniganj palynoassemblages have been identified in this sequence.

The limestone shale of Lilang Formation in the Lower Triassic sequence of Lingti Road and Lingti Hill sections, has yielded the Early Triassic palynofossils *Lundbladispora, Krempipollenites, Arcuatipollenites*. Quantitative determination of palynofossils is difficult because of poor recovery.

Beside the palynostratigraphic study, in view of field observation by two authors (TS and RA), the stratigraphic status of many litho units – Ganmachidam Formation and Gechang, Gungri Members is also discussed.

This manuscript was published very recently in *Journal of Geological Society of India.*

In the 30th International Geological Congress at Beijing, China, I shall give an oral presentation on the present knowledge of palynologic Permian- Triassic boundary transition in Tethys Himalaya and Indian peninsula, i.e. in marine *vis-a-vis* nonmarine sequence at the P/T boundary.

Vijaya
Assistant Director
Birbal Sahni Institute of Palaeobotany
Lucknow

12. THE PALYNOLOGY AND AGE OF KONGSHUHE FORMATION OF TENGCHONG BLOCK IN WEST YUNNAN, CHINA

Since the recovery in the 1970s of glacio-marine deposits of Late Palaeozoic age on the Baoshan and Tengchong Blocks, the geology (especially palaeontology) has been exhaustively studied by geologists in both China and abroad. However, work on the fundamental geology in both biostratigraphy and palaeobiogeography did not progress quickly until the 1990s. Two significant contributions are worthy of mention. One is the systematic sedimentary study of the upper Palaeozoic deposits on the Tengchong and Baoshan Blocks by Prof. Wopfner and Dr. Jin, and the other, the palynological study of the lower Permian rocks in Tengchong Block by the author.

Based upon the sedimentary study by Prof. Wopfner and Dr. Jin (1994), a three-fold clastic sequence consisting in ascending order of 1) diamictites and coarse clastics, 2) pebbly mudstones and laminites, 3) black pyritic, organic-rich mudstone (with or without carbonate concretions) of Late Carboniferous to Early Permian age, is widely distributed in the Baoshan block and Tengchong block of West Yunnan. They claimed that the Baoshan Block with its glacio-marine deposits apparently originated from a position proximal to issuing glaciers, possibly near the northwest-coast of Australia, while the Tengchong Block occupied a more peripheral position (Wopfner and Jin, 1993).

The controversy in age between fusulinids and other fauna (such as brachiopods) in Baoshan and Tengchong Blocks was discussed by Dr. Nie Zetong et al. (1993). They suggested late Carboniferous fusulinids were reworked into the lower Permian to explain the age controversy between fauna in their paper of "Biota Features of the Gondwana Affinity Facies and Review of their Stratigraphic Ages in Western Yunnan". They accepted the opinion of former workers that the following fusulinids: *Triticites ohioensis, T. pusillus, T. parvulus, Hemifusulina maoshanensis, H. pseudosimplex* etc. in Baoshan and Tengchong Blocks were assigned to the *Triticites* Zone of Ghzelian age. After re-examination of the fusulinids by Dr. Wang Yujing, it was concluded that the fusulinid assemblage in the above areas should belong to the *Pseudoschwagerina* Zone instead of the *Triticites* Zone because in addition the assemblage contains *EoparafusuIina (Triticites) pusilla, E. (Hemifusulina) maoshanensis, E. pseudosimplex.*

With the discovery of Gondwana type spores and pollen in Kongshuhe, Tengchong of West Yunnan, the geological age of the Kongshuhe Formation has been confirmed as early Permian (Asselian to Sakmarian). The spores and pollen were extracted from the above mentioned 3) black pyritic, organic-rich mudstone of the three-fold clastic sequences of Kongshuhe Formation. Most species are of Gondwana affinity. They are *Microbaculispora tentula, Jayantisporites pseudozonatus, Horriditriletes tereteangulatus, Propinguispora praetholu.s, Procoronaspora spinosa, Vittatina fasciolata, Prorohaploxypinus* sp., *Punctarisporites* cf. *gretensis, Retusotriletes* sp. This assemblage in Tengchong has been correlated to the well-studied Gondwana zones, such as the top part of Unit II in Canning Basin by Kemp et al. (1977); zone I in the Karoo Basin by Anderson (1977), as well as the *Granulatisporites confluens* Oppel-zone from the Grant Formation of the Barbwire Terrace, Canning Basin by Foster and Waterhouse (1988), and the *P, confluens* Zone in the Collie Basin by Backhouse (1991).

If we accept Wopfner and Jin's idea that the above mentioned 3) sequence of black shale and organic-rich mudstone in Tengchong represents deglaciation, we can then confirm the correlation from Petrography and Palynology between the Tengchong and Canning Basin. This conclusion strongly supports the suggestion that Tengchong was located quite close to West Australia at that time. Further detailed comparative studies based upon the material between Australia and West Yunnan hopefully will be initiated soon.

Dr. Yang Weiping
Nanjing Institute of Geology and Palaeontology
Academia Sinica, No. 39 East Beijing Road
Nanjing, 210008, P. R. China

13. DISCOVERY OF *PALAEOFUSULINA* FAUNA IN THE LOWER PART OF THE HESHAN FORMATION (EARLY WUCHIAPINGIAN IN LAIBIN, GUANGXI, CHINA

Palaeofusulina, one of the most widespread fusulinids in the latest Permian in Tethys, was regarded as the index fossil of the Changhsingian in China as well as in other regions of the Tethys (Sheng, 1963; Rui, 1979). It is now found having its first occurrence in the lower part of Heshan Formation in Laibin, Guangxi. The limestone succession and associated other fossils suggest an Early Wuchiapingian age.

The section with the *Palaeofusulina* fauna is located in Penglaitan 18 km east of Laibin County, Guangxi, where the Permian succession is completely exposed along the Hongsuihe River. Permian deposition was continuous except for a short time-gap between the Artinskian and Chihsian in this section. The formation is 150 m thick and is mainly composed of lime mudstone and siliceous lime mudstone with various fossils. The upper 20 m is composed of mudstone interbedded with limestone, yielding abundant Changhsingian ammonites *Pseudotirolites, Tapashanites* and *Changhsingoceras;* the middle 60 m is lime mudstone intercalated with siliceous limestone, siliceous rock, siltstone and coal seam, containing Wuchiapingian ammonites *Sangyangites, Zonglingites* and *Protoceras,* the conodont *Clarkina orintalis,* and plant fossils *Cordaites, Tanaeopteris;* the lower 70 m is siliceous limestone intercalated with limestone and siliceous rock, containing conodonts *Clarkina postbitteri* and *C. dukouensis* in its basal part. The basal contact with the underlying Maokou Formation was considered conformable based on the lithological and conodont succession (Jin et al., 1994). The top 8 m of Maokou Formation is composed of medium bedded to massive bioclastic wackestone and packstone, containing the Maokouan conodont *Mesogondolella altudaensis, M. xuhanensis* and *M. granti,* and the fusulinid *Codonofusiella.* In another section 14 km west of the Penglaitan Section the top 7 m of the Maokou Formation contains the above conodonts as well as typical Maokouan fusulinids *Metadoliolina doullvi, Colania* sp., *Chsenella* sp., *Kahlerina sinensis* and *Lantschichites minima.*

The *Palaeofusulina* fauna occurs in an interval between 10 m to 20 m above the Maokouan-Lopingian boundary in association with the conodont *Clarkina* cf. *asymetrica.* Nine species from 5 genera including *Palaeofusulina jiangxiana, P. fusiformis, P. minima, P, fluxa, P. parafusiformis, Gallowayinella laibinensis, Tewoella brevicylindrica, Nankinella* sp. and *Staffella* sp. have been recognized, of which *P. fusiformi's, P. minima* is widespread in the Changhsingian in South China; *P, jiangxiana* has a large shell and been reported in the *PaIaeofusulina sinensis* zone of Late Changhsingian in Loping, Jiangxi (Sheng et Rui, 1984); *T. brevicylindrica* was found in association with *Palaeofusulina minima* in Lopingian in Tewo, Gansu (Sun, 1979). *Gallowayinella laibinensis* is a new species proposed in this paper on its transitional morphology between *RussielIa, Gallowayinella* and *Tewoella.* It is similar to *Russiella pulchra M.-Maclay* in its smaller proloculum, an endothyroid juvenarium and it has irregularly fluted septa similar to that of *TewoelIa.* On the other hand it is similar to *Gallowayinella meirienensis* Chen by its rounded poles and compacted volutions. Kanmera et al. (1976) suggested that *Gallowayinella* is derived from *Russiella.* Our new species *G. laibinensis* gives a linkage between *Russiella* of Maokouan and the *Galloivayinella meitienensis* species group of the Late Wuchiapingian. *Tewoella* may also be derived from the G. *laibinensis* species group. This Wuchiapingian *Palaeofiisulina* fauna contains both primitive forms (P. *minima* and G. *laibinensis)* and advanced forms (P. *jiangxiana).* This suggests that Lopingian fusulinids have a rapid morphological divergence in the Wuchiapingian and that they flourished in the Changhsingian. The difference between this Wuchiapingian fusulinid fauna and Changhsingian fusulinid fauna is that the former is dominated by species of *Palaeofusulina* with fusiform shells and the latter by species of *PaIaeofusulina* with inflated fusiform shells.

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Zhu Zili
Nanjing Institute of Geology and Palaeontology
Academia Sinica Nanjing, China 210008

14. THE CHIHSIAN SERIES IN SOUTH CHINA

The Chihsia Limestone, named by Richthofen in 1882, was formally defined by Huang (1932) as a dark limestone between the light colour Chuanshan Limestone and the Kuhfeng Chert. In the type area, the fusulinids of this formation were grouped into four zones: *Misellina claudiae* zone, *Nankinella orbicularia* zone, *Schwagerina chihsiaensis* zone and *Parafusulina multiseptara* zone in ascending order (Zhou and Zhang 1984). The term Chihsian, was widely used as a stage with various modifications. A common usage of Chihsian is to represent the *Misellina* genozone, which is only correlated to the lower part of Chihsia Limestone (Kozur, 1977), but the Chihsian Series, proposed by Jin et al. (1994), is an equivalent of whole Chihsia Limestone corresponding with to the Bolorian, Kubergandinian and probably lower Murgabian in Pamir.

As a whole, there is no remarkable lithological and biological change within the Chihsian Series in South China. A sharp biota change has been reported between the Bolorian and the Kubergandinian in Pamir (Leven 1994, Bogoslovskaya and Leonova 1994), has not been recognized in South China. It seems that the faunal change of Bolorian/Kubergandinian is a local event resulting from regional environmental change rather than global. Within the Chihsian Series of South China, the only disputable horizon in South China *is Parafusulina multiseptata* zone. In Zhejiang (Wang and Tang 1986) and Anhui (Zhao 1989), the P. multiseptata zone contains *Praesumatrina neoschwagerinoides,* a characteristic species of Early Maokouan in its eponymous area of southern Guizhou. This overlapping part, roughly corresponding with the *Parafusulina multiseptata* zone of restricted shelf facies, the *Praesumatrina neoschwagerinoides* zone or the *Neoschwagerina simplex* zone of open shelves, has been assigned to the Chihsian by some Chinese stratigraphers and to the Maokouan by others. Other faunas of the overlapping part do not show a decisive difference from typical Chihsian faunas. Among the fusulinids, *Neoschwagerina* is a characteristic genus of Maokouan, *Praesumatrina* is restricted to the overlapping part, *Pseudodoliolina* and *Verbena* appear firstly in the bed slightly lower and flourish in the Maokouan, but a majority of component species belong to the genera *Schwagelina* and *Parafusulina* ranging from Chihsian to Maokouan. The Corals are typical of Chihsian, and the brachiopods reveal a transitional character between Chihsian and Maokouan. Including this part into the Maokouan, then the Chihsian would be correlatable to the Bolorian and Kubergandinian.

The lower boundary of the Chihsian Series is marked by an unconformity in successions of South China. It is this sharp lithological and faunal change from Chuanshan Limestone to Chihsia Limestone that lead Chinese stratigrapher to have taken it as the C/P boundary for decades. Recent investigation reveal that a regression took place in the latest Zisongian (latest Sakmarian) and the early Longliaian (early Artinskian) and a subsequent transgression occurred in the late Longlinian (late Artinskian) (Jin and Sheng, 1994; Zhu 1995). In the slope and basinal successions in eastern Yunnan, southern Guizhou and western Guangxi, deposition was continuous from the Zisongian to the Chihsian. Corresponding deposits of lowstand appear in the middle of Longlinian succession. *Neostreptognathodus exculptus,* a key species for the base of Kungurian occurs just above this level, the upper part of the *Pamirina darvasica* zone in the Luodien Section of Guizhou (Wang, 1994). This fact implies that the newly defined Kungurian Stage should include part of the Yachtachian in Pamir, and the upper Longlinian of South China.

With regard to the key conodont elements of the basal Guadalupian, *Jinogondolella nankingensis, I* has been reported in South China from several localities. The type locality of this species is the Kuhfeng Formation overlying the bed of *Para.fusulina multiseptata* Zone in Nanjing. It has been found from the top part of the Chihsian Formation in Susong and Tongling County, Anhui, below the Kuhfeng Formation with J. *aserrara* and J. *postserrata*. (Wang et al., 1993). Occurrence of *Praesumatrina neoschwagerinoides* in a bed 90 in below the top of the Chihsia Formation in Guichi Section close to the Sosung Section suggests a possibility that J. *nankingensis* appears above the bed with P. *neoschwagerinoides.* In Ziyun and Luodien, southern Guizhou, J. *nankingensis* occurs in the beds of *Neoschwagerina margaritae* zone and *Yabeina inouyei* zone. The available data suggest that J. *nankingensis* occurs in higher level than the fusulinid P. *neoschwagerinoides* does in South China. However, *Mesogondolella phosphoriensis,* regarded as Wordian in age by Behriken et al. (1986) and from Roadian to Wordian by Kozur(1995), occur in the beds of the *Misellina paramegalocuId* zone. T'his means that the base of that fusulinid zone of Luodianian, correspondent with the base of the Kubergandinian, is correlatable to the base of the Roadian, a correlation supported by the data of ammonoids from the basal part of the Kubergandian in Pamir (Bogoslovskaya and Leonova 1994, Leven 1994, Davydov 1994, Kotlyar 1995). Ibis conclusion is contradictory to the occurrence of *M. idahoensis,* a typical late Cathedralian element in the same level.

AGE		FUSULINID ZONE	CONODONT ZONE
Maokouan		*Afghanella tereshkovae*	
Chihsian Series	Xiangboan	*Praesumatrina neoschwagerinoides*	
		Cancellina dutkevichi	*Mesogondolella siciliensis-M. phosphoriensis*
	Luodianian	*Misellina paramegalocula*	*M. idahoensis-M. phosphoriensis*
		Misellina termieri	*M. gojioensis-M. intermedia*
		Brevaxina dyhrenfurthi	*M. shindyensis-Neostreptognathodus leonovae*
Chuanshanian Series	Long-linian	*Pamirina globosa*	*N. exculptus-M. bisselli*
		Pamirina darvasica	
	Zisong-ian	*Robustoschwagerina ziyunensis*	*M. bisselli-Sweetognathus whitei*

Late Chuanshanian and Chihsian conodont and fusulinid sucession in Luodien, southern Guizhou (modified from Zhu and Zhang, 1994)

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Zhu Zili
Nanjing Institute of Geology and Palaeontology,
Academia Sinica, Chi-Ming-Ssu, Nanjing 210008 China

15. ANALOGUE OF THE UFIMIAN, KAZANIAN AND TATARIAN STAGES OF RUSSIA IN NORTH-WESTERN CHINA BASED ON MIOSPORES AND BIVALVES

According to regional stratigraphic schemes the Upper Permian of the Urals and Russian Platform is subdivided into stages, substages, horizons. Their stratotypes are situated in the European part of Russia (Figures 1, 2). Ufimian Stage, Solikamsky Horizon (Fig. l, stratotype section I). This horizon yields abundant miospores. The spores in the palynological assemblages (PA) are represented by subturma Azonotriletes Luber and Zonotriletes Waltz. Azonotriletes includes single specimens of the genera *Calamospora*, *Punctatisporites*, *Cyclogranisporites*, *Granulatisporites*, *Eikshorisporites*, *Acanthotriletes*, and *Raistrickia*. Zonotriletes episodically dominates and includes the following species: *Cirratriradites ornatus* (Luber), *C. procumbens* (Luber), *Kraeuselisporites setulosus* Virbitskas, *Kraeuselisporites* sp. Among the pollen infraturma Costati Jansonius predominates. It mainly consists of abundant *Weylandites striatus* (Luber), significant amounts of *Vittatina costabilis* Wilson, *V. subsaccata* Samoilovich ex Wilson, *Weylandites persecrus* (Sauer), *Ventralvittatina vittifera* (Luber) f.minor Samoilovich, *V. tumida* Koloda. Striatiti Pant dominates, including a considerable amount of *Protohaploxypinus perfectus* (Naumova), *P. perfectiformis* (Poluchina), *P. latissimus* (Luber), *Hamiapollenites tracfiferinus* (Samoilovich) and sporadic *Striatoabieites brickii* Sedova, *S. elongatus* (Luber), *S. striatus* (Luber), *Hamiapollenites bullaeformis* (Samoilovich), *Paucistriatopinites* sp. Subturma Monosaccites Chitaley emend. Potonie and Kremp subdominates in the PA, and it is represented by *lunctella ovalis* Kara-Mursa ex Djupina, *I. rotunda* Kara- Mursa ex Djupina, *Florinites luberae* Samoilovich, *Cordaitina uralensis* (Luber), *Luberisaccites convallatus* (Luber). Limitisporites latus Leschik, *L. monstruosus* (Luber), *Illinites parvus* Klaus, *1. pemphicuus* Klaus, *Jugasporites delasaucei* (Potonie et Klaus), *Gardenasporites leonardii* Klaus, *G. magnus* Hou et Wang, *Gigantosporites* sp., *Vesicaspora wilsonii* Schemel, *V. schemeli* Klaus, *Alisporires sublevis* (Luber) are among the nontaeniate saccate pollens.

Association of nonmarine bivalves is present in the upper part of Solikamsky Horizon and represented by species: *Redikorella starobogatovi* (Kanev), *R. kanevi* Silantiev, *Palaeomutela oblonga* (Krotow), *P. voinovae* (Kanev), *P. grata* Kanev, *KhosedaeIla subconcentrica* (Krotow), *Kh. permica* Kanev, *ICh. alta* (Pogorevitsch), *Neoanthraconaia angusta* (Kanev), *Intaella trapezoidalis* (Krotow), *Anthraconauta declive* Kanev, *Concinnella angulata* Pogorevitsch. There are three marine layers (Borovsky, Pyskorsky, Dobryansky) in the stratotypical section of the Solykamsky Horizon. *Stutchburia* (Netschajewia) *tschernyschewi* Licharew, *Pleurophorus costatus* Brown have been found in the Borovsky layer. The Dobryansky layer contains *Schizodus rossicus* Verneuil, *Solemya* (Janeia) *solikamica* Muromzeva, *Bakewellia bicarinata* King., *Pseudobakewellia ceratophagaeformis* Noinskyi, *Promytilis retusus* Chronick.

Sheshminsky Horizon (Fig. 1-II).The spores in the Sheshminsky Horizon are more diverse. *Leiotriletes subintortus* (Waltz), *Verrucosisporites varkaensis* Virbitskas, *Jaroslavtsevisporites*

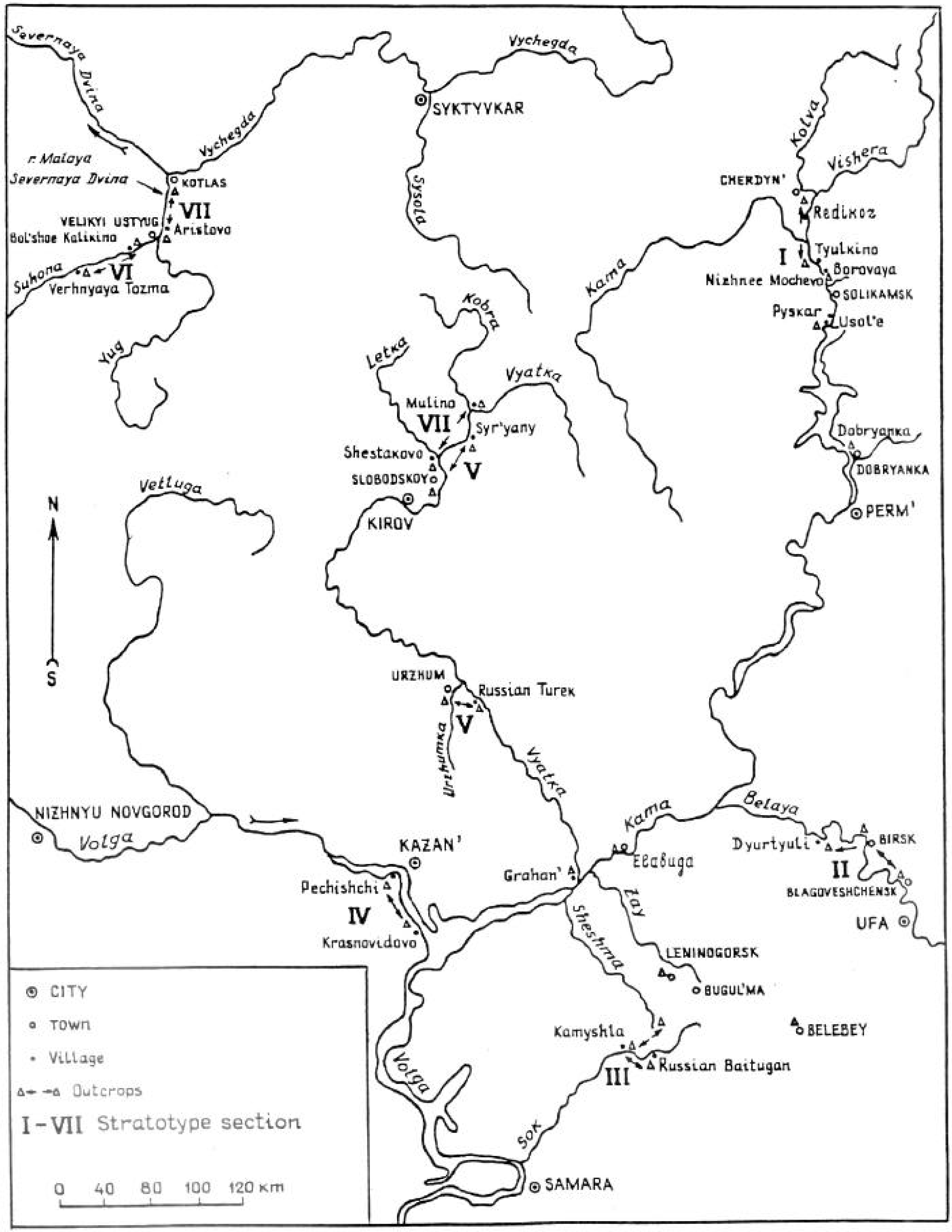

Figure 1. The location of the Upper Permian stages stratotype sections.

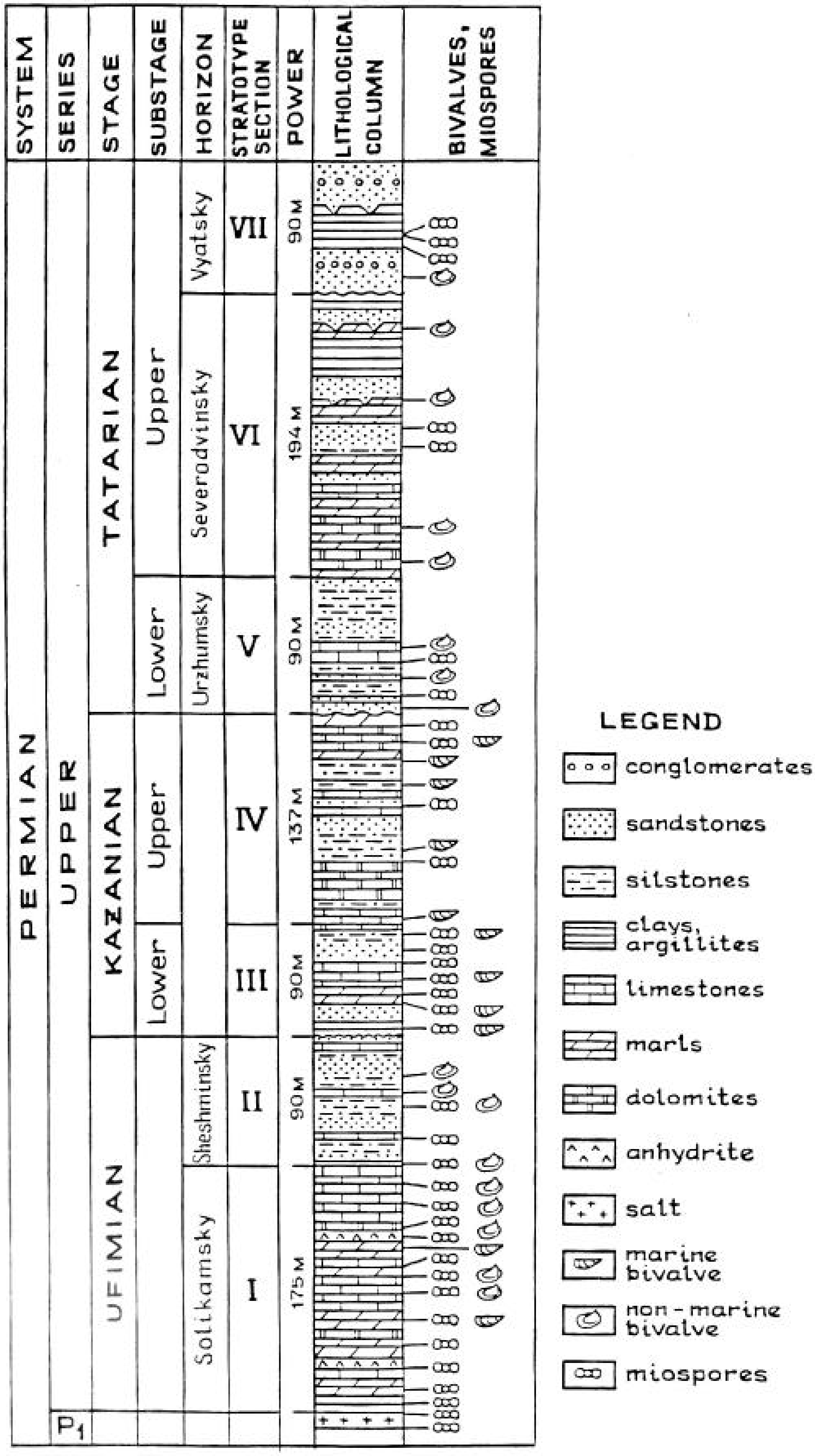

Figure 2. Lithostratigraphical summary log for the Upper Permian of the Stratotype region.

aculeolatus Belozertseva et Virbitskas, *Kraeuselisporites vulgaris* f. *elegans* (Luber ex Warjuchina), *Lunulasporites vulgaris* Wilson appear in this PA. Among the pollen *Vesicaspora wilsonii* Schemel dominates, *FIorinites luberae* Samoilovich, *Cordairina uralensis* (Luber), *Luberisaccites subrotatus* (Luber), *Crucisaccites ornatus* (Samoilovich), *Limitisporites monstruosus* (Luber), *Gigantosporites* spp., *Striatolebachiites* spp., *Protohaploxypinus nudus* (Luber), *P. suchonensis* (Sedova), *Vittatina costabilis* Wilson and V.subsaccata Samoilovich ex Wilson episodically subdominate.

The association of nonmarine bivalves of the Sheshminsky Horizon stratotype and the Elabuga section includes the following species: *Palaeomutela goldfussiana* (Krotow), *P. stegochephalum* Netschajew, *P. opima* (Kanev), *P. ovataeformis* Gusev, *Intaella tzapezoidalis* (Krotow), *I. komiensis* (Kanev), *Abiella ovara* (Betekhtina), *A. kolvae* Kanev, *Concinnella vertnajensis* Kanev, C. *insueta* Kanev, *Anthraconauta uralica* Kanev, *A. probus* Kanev.

Kazanian Stage, Lower Substage (Fig. 1-III). The PA are characterized by small amounts of different spores and by abundant pollen. The single specimens of *Calamospora* cf. *C. breviradiata* Kosanke, *C. plicata* (Luber et Waltz), *Punctatisporites* cf. *P. punctatus* Ibrahim, *Leiotriletes subintortus* (Waltz), *Cyclogranisporites aureus* (Loose), *Jaroslavtsevisporites aculeolatus* Belozertseva et Virbitskas, *Verrucosisporites varkaensis* Virbitskas, *Lophotriletes spinosellus* (Waltz), *Pustulatisporites strobilatus* Belozertseva et Virbitskas, *Capillatisporites tenuispinosus* (Waltz), *Brevitriletes hispidus* Andreeva, *Apiculatisporites* sp., *Acanthotriletes rectispinus* (Luber), *Raistrickia obtusosaetosa* (Luber), *Horriditriletes* sp., *Cirratriradites procumbens* (Luber), *Lunulasporites vulgaris* Wilson are present in the PA from Lower Kazanian Substage. Among the pollen the most representative groups are Disacciatrileti Leschik, Striatiti and Costati. These are mainly composed of *Vesicaspora schemeli* Klaus, *Alisporites nuthallensis* (Clarke), *A. splendens* (Leschik), *Klausipollenites* sp., *Protohaploxypinus perfectus* (Naumova), *P. perfectiformis* (Poluchina), *Vittatina costabilis* Wilson, *V. subsaccata* Samoilovich ex Wilson and *Weylandites striatus* (Luber). Several species, such as *Striaropodocarpites tojmensis* Sedova, *Protohaploxypinus latissimus* (Luber), *Hamiapollenites bullaeformis* (Samoilovich), *H. tractiferinus* (Samoilovich), *Striatolebachiites varius* (Sauer), *Ventralvittatina rotunda* Koloda, are subdominate. The pollen *Florinites luberae* Samoilovich, *Cordaitina uralensis* (Luber), *Luberisaccires subrotatus* (Luber), *Libumella rugulifera* (Luber) are sporadic. *Limitisporites aureus* (Luber), *L. rectus* Leschik, *L. latus* Leschik, *L. monstruosus* (Luber), *Gardenasporites heisseli* Klaus, *G. leonardii* Klaus, *G. moroderi* Klaus are rare.

Marine bivalves include – *Nuculana kazanensis* (Vemeuil), *Lithophaga consobrina* (Eichwald), *Pseudobakewellia ceratophagaeformis* Noinsky, *Pseudomonotis speluncaria* Schlotheim, *Schizodus rossicus* Verneuil, *Stutchburia* (Netschajewia) *globosa* (Netschajew) in the Lower Kazanian stratotype section.

Upper Kazanian Substage (Fig. 1-IV). The spores in the PA are more monotonous compare to the Lower Kazanian one. Among the pollen Striatiti and Costati also dominate, Disacciatrileti subdominates, but Monosaccites and Disaccimonoleti in this PA are rare. The main species of pollen are *Protohapioxypinus perfectus* (Naumova), *Vittatina subsaccata* Samoilovich ex Wilson and *Weylandites striatus* (Luber). In individual samples a considerable amount of *Prorohaploxypinus latissimus* (Luber), *Florinites luberae* Samoilovich, *Acusporidatina reticuloida* Koloda, *Vitreisporites signatus* Leschik, *Vesicaspora schemeli* Klaus have been observed. Among scarce pollens, such as *Striatopodocarpites* spp., *Protohaploxypinus perfecriformis* (Poluchina), *P. jacobii* (Jansonius), *P. samoilovirchii* (Jansonius), *Hamiapollenites tractiferinus* (Samoilovich), *Paucistriatopinites* spp., *Vittatina costabilis* Wilson, *Ventralvittatina rotunda* Koloda, *Weylandites striatus* (Luber) f. *angusticostata* Sauer, a new species *Lueckisporites virkkiae* Potonie et Klaus appears by this time.

Palaeontologists from Kazan have described bivalves from the Upper Kazanian Substage: *Nuculopsis trivialis* (Eichwald), *Modiolus modiolaloidea* Netschajew, *Solemya (Janeia) kazanensis* (Stukenberg et Netschajew), *Liebea seprifer* King, *Aviculopecten rossiensis* Netschajew, *A. sectilicostatus* Netschajew, *Palaeolima permiana* (King), *Pseudomonotis kazanensis* Verneuil, *Pseudobakewellia krasnowidowiensis* (Netschajew), *Stutchburia (1Vetschajewia) elongata* (Netschajew), *St.* (N.) *alara* Netschajew, *St.* (1V.) *oblonga* (Golowkinsky), *Pleurophorina simplex* (Keyserling), *Prospondulus liebeanus* Zimmermann, *VacuneIla lunulata* (Maslennikov), *Oriocrassatella plana* (Golowkinsky), *Siphogrammyssia kazanensis* (Geinitz) (Netschajew, 1894; Soloduho, Tihvinskaya, 1977).

Marine deposits of the Kazanian Stage stratotypes (Pechishchi-Krasnovidovo-Kamyshla) gradually change for lagoonal-continental deposits towards east. The Kazanian Stage in the Grahan (river Vyatka), Leninogorsk (river Stepnoy Zay), Belebey (river Belebeika) are represented by continental deposits with nonmarine biotx flora, miospores, ostracods, bivalves, insecta, vertebrates (Fig.l; Varyuhina et al., 1981, text-figs 10-12). The assemblage of bivalves is characterized by *Palaeomutela attenuata* Gusev, *P. umbonata* Fischer, *P. pseudoumbonata* Gusev, *P. quadriangularis* (Netschajew), *P. krotowi* Netschajew, *P. olgae* Gusev, *Neoanthraconaia longissima* (Netschajew), *N. rhomboidea* (Netschajew), *N. sambulakovi* (Kuloeva), *AbieIla subovata* (Jones).

The Tatarian Stage is subdivided into two Substages. The Lower Substage with one horizon - Urzhumsky, and the Upper Tatarian with two, i.e. the Severodvinsky Horizon and Vyatsky Horizon (Fig.2). PA of Urshumsky Horizon (Fig. 1-V) was studied from the well in the stratotypic region. In the lower part of this horizon miospores are characterized by abundant Striatiti and Costati, by a subdominance of Disacciatrileti. The main species are *Alisporites splendens* (Leschik), *A.nuthallensis* (Clarke), *Vesicaspora schemeli* Klaus, *Protohaploxypinus amplus* (Balme et Hennelly), *P. perfectus* (Naumova), *P. suchonensis* (Sedova), *Striatolebachiites* spp. *(S.varius, S.* sp.), *Vittatina costabilis* Wilson, *V. subsaccata* Samoilovich ex Wilson, *Vittatina* sp. and *Weylandites striatus* (Luber). In addition, *Scheuringipollenites ovatus* (Balme et Hennelly), *Protohaploxypinus jacobii*

(Jansonius), *P. samoiIovitchii* (Jansonius), *Ventralvittatina rotunda* Koloda are common. Sporadic specimens of pollen include *Limitisporites moersensis* Klaus, *Gardenasporites heisseli* Klaus, *Vitreisporites signatus* Leschik, *Falcisporites zapfei* (Potonie et Klaus), *Platysaccus papilionis* Potonie et Klaus, *Gigantosporites* sp., *Pteruchipollenites* sp., *Protohaploxypinus* minor (Klaus), *Striatopodocarpites antiquus* (Leschik), *Striatoabieites wilsonii* (Klaus), *S. jansonii* (Klaus), *S. multistriatus* (Balme et Hennelly), *S. richteri* (Klaus), *Paucistriatopinites* sp., *Lueckisporites virkkiae* Potonie et Klaus, *Weylandites striatus* (Luber) f. *angusricosrata* Sauer, Vittatina cf. *hiltonensis* Chaloner et Clarke, *Fusacolpites ovatus* Bose et Kar. The spores include single specimens of *Cyclogranisporites aureus* (Loose), *Jaroslavtsevisporites aculeolatus* Belozertseva et Virbitskas, *Lophotriletes spinosellus* (Waltz), *Apiculatisporites* sp., *Kraeuselisporites* sp., *Laevigatosporites callosus* Balme, *Punctatosporites* sp.

The typical association of nonmarine bivalves in the Urzhumsky Horizon includes the following species: *Palaeomutela vjatkensis* Gusev, *P. extensiva* Gusev, *P. krotowi* Netschajew, *Prilukiella mirabilis* (Gusev), *P. nitida* Gusev, *P. lata* (Netschajew), *Neoanthraconaia castor* (Eichwald), *Concinnella concinna* (Jones), *C. alla* (Ragozin), *Anadontella subparallela* (Khalfin), *Anthraconauta acuta* Khalfin, *A. volgensis* Gusev, *A. uslonensis* Gusev.

Severodvinsky Horizon (Fig. 1-VI). PA of the Severodvinsky Horizon contains more pollen, than spores. The pollen are mainly composed of Disaccites, represented by *Alisporites nuthallensis* (Clarke), *A. splendens* (Leschik), *A. sublevis* (Luber), *A. tenuicorpus* Balme, *Vitreisporites* spp. (V. *elegans, V. subrotatus, V. pallidus), Protohaploxypinus amplus* (Balme et Hennelly), *P. latissimus* (Luber), *P. perfectus* (Naumova), *P. suchonensis* (Sedova), *Striatolebachiites* spp. In individual samples there may be many *Giganrosporites* spp., *Lueckisporites virkkiae* Potonie et Klaus and a few *Pteruchipollenites reticorpus* Ouyang et Li, *KIausipollenites schaubergeri* (Potonie et Klaus), *Striatopodocarpires pantii* (Jansonius), *Scutasporites* spp., *Taeniaesporites* spp., *Vittarina* sp.

Association of the nonrnarine bivalves in the Severodvinsky Horizon includes *Palaeomutela subparallela* Amalitzky, *P. keyserlingi* Amalitzky, *P. orrhodonta* Amalitzky, *Oligodontella tetraedroides* (Plotnikov), *Opokiella tschernyschewi* Plotnikov, *Verneuilanio verneuili* (Amalitzky). *Palaeanodonta netschajewi* Lobanova.

Vyatsky Horizon (Fig.l-VII). PA of the Vyatsky Horizon has been determined from the Aristovo section (Malaya Severnaya Dvina river). Its spores include *Calamospora landiana* Balme, *C. nathorstii* (Helle), *Osmundacidites senectus* Balme, *Verrucosisporites* sp., *Brevitriletes* spp., *Apiculatisporites decorus* Singh, *Apiculatisporites* sp., *Limatulasporites fossulatus* (Balme), *Polypodiisporites* sp., *Kraeuselisporites spinosus* Jansonius, *Kraeuselisporites* sp. The pollen are mainly represented by *Vitreisporites* spp. (V. *pallidus, V. brevis, V. signatus, V. subrotatus), Alisporites nuthallensis* (Clarke), *A. splendens* (Leschik), *Protohaplo.rypinus suchonensis* (Sedova), *Striatolebachiites* spp. and less by *Klausipollenites schaubergeri* Klaus, *Pteruchipollenites reticorpus* Ouyang et Li, *Protohaploxypinus microcorpus* (Schaarschmidt), *P. samoilovitchii* (Jansonius), *Striatopocarpites pantii* Jansonius, *Striatoabieites leptosetus* Hou et Wang, *Lueckisporites singhii* Balme, *Ephedripites* sp. Its specific feature is in more notable amount of *Cedripites priscus* Balme, *Cedripites* sp., *Lueckisporites virkkiae* Potonie et Klaus, *Taeniaesporites labdacus* Klaus, *Taeniaesporites* sp., *Scutasporites* spp. *Scheuringipollenites ovatus* (Balme et Hennelly), *Platysaccus papilionis* Potonie et Klaus, *Klausipollenites stapiinii* Jansonius, *Protohaploxypinus minor* (Klaus), *Vitratina hiltonensis* Chaloner et Clarke, *Inaperturopollenites nebulosus* Balme in this PA are rare. The bivalves in the stratotype section of the Vyatsky Horizon are rare too. They are represented by *Palaeomutela curiosa* Amalitzky, *P. plana* Amalitzky, *Oligodontella geinitzi* (Amalitzky), *Neoanthraconaia solemyaeformis* (Netschajew). The most complete sets of miospores and bivalves, with their biostratigraphical analyses in the stratotypical sections of the Ufimian, Kazanian and Tatarian Stages have been described in our publications (Varyuhina et al., 1981; Kanev, 1986, 1995; Molin et al., 1986; Koloda, Molin, 1995).

According to the characteristics of spores, pollen and bivalves assemblages we correlate the of Ufimian, Kazanian and Tatarian Stages stratotypes with stratigraphic divisions of the Permian sections in Northern Xinjiang (China), containing abundant fossils, such as miospores, megaspores, floras, bivalves, ostracods, vertebrates (Yang et al., 1984; Permian and Triassic strata ..., 1986; Hou et Wang, 1990; Brand, Yochelson, Eagar, 1993; Sheng et Jin, 1994) (Fig. 3).

Lucaogou and Hongyanchi Formations (Upper Jijicao Group) have been correlated with the Ufimian Stage. These formations are characterized by PA *Cordaitina- Hamiapollenites-Vit1atina*, in which *Cordaitina uralensis* (Luber), *C. rotata* (Luber), *Libumella rugulifera* (Luber), *Crucisaccites ornatus* (Samoilovich), *Hamiapollenites bullaeformis* (Samoilovich), *H. tractiferinus* (Samoilovich), *Protohaploxypinus perfectus* (Naumova), *Ventralvittatina vittifera* (Luber), *Vittatina costabilis* Wilson are main taxa as in the Ufimian Stage. Bivalves from Lucaogou and Hongyanchi Formations are poorly studied. The few genera known are *Anthraconauta, Mrassiella, Microdonta, Palaeanodonta* (Sheng, Jin, 1994, p. 73). According to modern systematics of Permian nonmarine bivalves *Mrassiella* Ragozin corresponds to *Intaella* Kanev, 1989, and *Microdonta* Khalfin (from lower layers of Upper Permian) to *Khosedaella* Kanev, 1983. They are typical of the Ufimian Stage (Kanev, 1995).

The PA *Alisporites-Protohaploxypinus-Sulcatisporites* of the Quanzijie Fm. (Lower Changfanggou Group) is dominated by pollen, generally containing *Cordaitina uralensis* (Luber), *Crucisaccites ornatus* (Samoilovich), *Hamiapollenites tractiferinus* (Samoilovich), *Platysaccus, Vittatina, rarely-Protohaploxypinus* and *Gardenasporites*, various spores. The spores are sporadic and contain *Punctatisporites* cf. *P. punctatus* Ibrahim, *Cyclogranisporites aureus* (Loose), *Acanthotriletes* cf. *multisetus* (Luber)(*Kikshorisporites superbus* Virbitskas), *Kraeuselisporites*. This PA is compared with the PA of the Kazanian Stage. This formation contains bivalves *Palaeonodonta*

N.A.Koloda, G.P.Kanev, 1994, with specification					
Stratotype region (Russia)				Northern Xinjiang	
System	Series	Stage	Horizon	Group	Formation
Permian	Upper	Tatarian	Vyatsky	Gangfang gou	Guodikeng
			Severodvinsky		
			Urzumsky		Wulonggou
		Kazanian			Quanzijie
		Ufimian	Sheshminsky	Jijicao	Hongyanchi
			Solikamsky		Lucaogou

N.K.Esaulova, 1995			
Volga-Ural region (Russia)		Xinjiang (Jungar basin)	
Stage	Substage	Group	Formation
Tatarian	Upper	Xiaoquangou	Karamay
	Lower	Gangfanggou	Shaofanggou
			Jiucaiyuan
Kazanian	Upper		Guodikeng
	Lower		Wutonggou
			Quanzijie
Ufimian	Upper		Hongyanchi
	Lower	Jijicao	Lucaogou

Figure 3. Comparison of the stratigraphical schemes of correlation of the Upper Permian in western Russia and north-western China.

cf. *longissima* (Netschajew), *P. solonensis* Liang, *Anthraconauta iljinskiensis* Fedotov. The first of them is a typical species of *Neoanthraconaia* Kanev, 1995 and is a characteristic species in the continental facies of the Kazanian Stage (Kanev, 1995). *Palaeanodonta solonensis* with morphological peculiarities is close to *Palaeanodonta oblonga* Belova from Kazankovo-Markinsky regiohorizon of the Kazanian Stage in Kusbass. The *Anthraconauta iljinskiensis* is a biozonal form of the Kazankovo-Markinsky Horizon. The Quanzijie Fm. by its bivalve association is correlated with red-coloured and coalbearing facies of Kazanian Stage in Russia.

The PA *Kraeuselisporires-Potonieisporites-Sulcatisporites* of Wutonggou Fm. and PA *Limatulasporites-Alisporites-Lueckisporites* of the Guodikeng Fm. (Lower Cangfanggou Group) are rather similar to the PA of the Tatarian Stage. The genera and species of miospores in these formations include *Calamospora nathorstii* (Helle), *Apiculatisporites decorus* Singh, *Verrucosisporites, Tuberculatosporites homotubercularis* Hou et Wang (*Polypodiisporites* sp.), *Potonieisporites turpanensis* Hou et Wang *(=Gigantosporites* **sp.),** *Pteruchipollenites reticorpus* Ouyang et Li, *Vitreisporites pallidus* (Reissinger), *Elausipollenites schaubergeri* (Potonie et Klaus), *Protohaploxypinus minor* (Klaus), *Taeniaesporites, Lueckisporites virkkiae* Potonie et Klaus. The PA from the Wutonggou and Guodikeng formations are of Tatarian age. Bivalves *Palaeomutela keyserlingi* Amalitzky, *P. orthodonra* Amalitzky, *Palaeanodonta* castor (Eichwald), *P. subcastor* Amalitzky, *P. fischeri* Amalitzky have been established from the lacustrine deposits of the Wutonggou Fm. (or Xiolongkou), developed north of Turpan (Brand et al., 1993, text-fig. I). From the Guodikeng Fm. in the Dalongkou area of Simsar *Palaeanodonta brevis* Liang, *P.* cf. *parallela* Amalitzky have been described (Zhang Yuxiu in "Permian and Triassic strata,.", 1986). These associations are close to bivalves assemblage of the Severodvinsky Horizon of Tatarian Stage in Western Russia by the taxonomic composition.

Thus, the Lucaogou and Hongyanchi Formations age is Ufimian, and the Quanzijie Fm. is Kazanian, the Wutonggou and Guodikeng Formations are Tatarian (Koloda, Kanev, 1994 and in this paper Fig. 3).

A different correlation of Upper Permian Stages with Permian and Triassic stratigraphic divisions in Northern China, based on the flora, was published by N.K. Esaulova (1995). In this paper by N.K. Esaulova the Lucaogou and Hongyanchi Formations (Upper Jijicao Group) were correlated with the Ufimian Stage, the Quanzijie, Wutonggou and Guodikeng formations (Lower Cangfanggou Group) - with the Kazanian Stage, the Jiucaiyuan, Shaofanggou formations (Upper Cangfanggou Group) and Karamay Formation (Lower Xiaoquangou Group) - with the Tatarian Stage (Fig. 3).

We believe, that N.K. Esaulova made an error in the biostratimaphical correlation of the Upper Permian deposits of the Volga-Ural region with North-West China.

Palynologists in China have established and described Triassic PA from the Jiucaiyuan, Shaofanggou, Karamay, Huangshanjie and Haojiagou Formations (Qu et Wang, 1990; *in* "Permian and Triassic...", 1986). The Triassic age of these PA, formations and the position of Permo-Triassic boundary within the Cangfanggou Group has been proven by them.

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Dr. Nina Koloda, Dr. Gennady Kanev
Institute of Geology,
Komi Science Centre Urals Branch of RAS
167000. Syktyvkar, Pervomajskaja str., 54.

16. KUNGURIAN AND UFIMIAN PERMIAN HYPOSTRATOTYPES IN NORTH CISURALS, PECHORA

The Permian system stage scale was elaborated on the basis of Urals and Russian Platform sections. However, in the stratotypical region Kungurian and Ufimian stages are represented by either sea-coastal or continental facies, which leads to difficulties with their identification in marine basins. Presently, there are a number of suggestions regarding recognition of these stages in other continents: in North America, China, Australia. Meanwhile, correlation potential of the Urals sections that have a very advantageous geographic location, are still not being used in the Cisurals to their full capacity. For example, to the north of the stratotypical region in the Pechora Cisurals analogues are known of the Kungurian and Ufimian stages. In these units - besides continental sediments - marine and subsaline-water sediments containing abundant and various fauna, flora and rich palynologic complexes, traditionally corresponding to the European scale are known.

Analogues of the Kungurian stage in the area are the sediments of Lekvorkutskaya suite outcropping along the Vorkuta River and represented by cyclic alternations of marine, lagoon-marine and continental sediments. These include sandstones, siltstones, claystones, coaly claystones and coals. Beds with marine fauna alternate with those containing flora. The fauna is represented by brachiopods, pelecypods, bryozoans, gastropods, ostracods, foraminifers; flora are represented by cordaiteans, lycopods, arthrophytes, pteridophytes, gymnospermous seeds, etc. Within the suite 13 horizons with marine fauna and 4 zones of freshwater pelecypods, 8 floristic zones and horizons, and 3 palynozones are marked. The Lekvorkutskaya suite boundaries, that are observed in the Vorkuta River exposures, are marked with horizons, containing marine fauna. The suite's thickness ranges from 1000 to 1200 in. The section is located within Vorkuta city limits, and is open and accessible. Besides Kungurian stage analogues along Vorkuta River there are well exposed analogues of Artinskian, Sakmarian, Assehan, and the lowermost strata of Ufimian stage.

Analogues of the Ufimian stage in the Pechora Cisurals are: Intinskaya, Kooshorskay, Tabyuskaya and other suites connected by lateral transitions. Mainly, these suites are represented by continental facies, and it is only in the northern part of the region that in Intinskaya (rivers SilovaYaha, Nyamdo-Yu, Hei-Yaga, Yangarey) and Tabyuskaya (rivers Tab-Yu, Yer-Yaga, Leoor-Yaga) suites containing marine fauna and defining boundaries, are known. It should also be noted, that along the Yer-Yaga River marine fauna occurs stratigraphically up section in sediments of the Yeryaginskaya suite, the analogues of the Kazanian stage (Guskov, V.A., Pukhonto, S.K., Yatzuk, N.Y., 1980).
On the basis of the evidence given above, we think that these Pechora North Cisurals sections should be used as hypostratotypes of the Kungurian and Ufirnian stages.

SVETLANA KIRILLOVNA PUKHONTO
(OTJSC TOLYARNOURALGEOLOGIA', RUSSIA)

17. PERMIAN PLANT LOCALITIES IN THE NORTHERN CISURALS (see Fig. I p. 26)

Localities of Vorkuta Series (Kungurian – Lower Ufimian) (&) of Pechora Series (Upper Ufimian Tatarian) (B) according to Neuburg, 1965:

1 - Er-Yacra and Liur-Yaga rivers
2 - Tab-Yu river
3 - Bolshaya Talata river
4 - Yangarey river
5, 6 - Khey-Yaga river
7 - Talbey-Shor river
8 - Nadoto river
9, 10 - Namda-yunko brook
I I - Nyamda-Yu river
12 - Nyarndavozh river
13 - Sylova-yaga river
14 - Khalmeryu coal field
15 - Nezarnetny brook
16 - Parallelny brook
17 - Verkhnesyryaga coal fiel
18 - Promezhutochny brook
19 - Buradan river
20 - Nizhnesyryaga coalfield
21 - Vorgoshor coalfield
22 - Vorkuta coalfield
23 - Yunyaga coalfield
24, 25 - Vorkuta coalfield
26 - Eletsk coalfield
27 - Usa coalfield
28 - Talbey coalfield (Adzva river)
29 - Usa river
30, 31 - Necha river
32 - Inta coalfield (Bolshaya Inta river)
33 - Kyn-Yu river
34 - Sed-El river
35 - Bolshaya Synya river
36 - Bolshoy Aranez river
37 - Khudaya river
38, 39 - Perebor river
40, 41, 42 - Pechora river
43 - Ust-Voya river
44 - Danko-Shor brook
45 - Pechora river between Mal. and Bol. Soplyas
46 - Bol. Patok river
47 - Podcherem river
48 - Shchugor river
49 - Usa coalfield
50 - Nizhnesyryaga coalfield
51 - Borehole SDK-1249
52 - Inta-Necha profile, borehole IK-465

Localities of Lower Permian plants according to Vladimirovich, 1981, 1986:

53 - Kozhim river, outcrops 201 and 202 of V.P. Gorski, 1972. Ayach-Yaga and Rudnizk Fms. Kungurian (Vladimirovich, 1986)
54 - Shchugor river, near the mouth of Sr. Vorot river. Vochael Fm., Artinskian (Vladimirovich, 1981 + Daranin Fm., Kungurian (Vladimirovich, 1986)
55 - Bol. Katya-el river, tributary of the Shchugor river. Daranin Fm., Kungurian (Vladimirovich, 1986)
56 - Shchucgor river, near the mouth of Mal. Patok river. Vochael Fm., Artinskian (Vladimirovich, 1986)
57 - Shchugor river near Michebichevnik village. Orlovkino Fm., Artinskian (Vladimirovich, 1981).

Localities of Permian plants according to Pukhonto and Fefilova, 1983:

58 - Talata river. Eryaga Fm., Upper Ufimian-Lower Kazanian
59 - Talata river, Tabyu Fm., Lower Ufimian
60 - Boreholes VK- 18, VK- 19, Seida Fm., Upper Ufimian-Lower Kazanian
61 - Boreholes VK-17, VK-20, VK-27. Talbey Fm., Upper Kazanian-Tatarian
62 - Paemboy coalfield, boreholes HK-1064, HK-1056, HK- 1065. Talbey Fm., Upper Kazanian-Tatarian
63 - Khalmeryu coalfield, borehole 1057. Talbey Fm., Upper Kazanian-Tatarian
64 - Seida coalfield, borehole SDK-74. Talbey Fm., Upper Kazanian-Tatarian

Localities of Permian plants according to Chalyshev and Varyukhina, 1968:

65 - River Sharyu, Chernyshev uplift. Ufimian and Kazanian
66 - Russell creek. Seida Fm., Kazanian
67 - Kosyu river. Inta and Seida Fms., Ufimian and Kazanian
68 - Kosyu river. Ufimian
69 - Sasha-El creek, Bol. Synya river basin. Kazanian and Tatarian
70 - Sasha-El creek, Bol. Synya river basin. Ufimian

Localities of Permian plants according to Smoller, 1988: 71 - Bagan area. Analogs of Inta Fm. and Pechora Series 72 - Veyak area. Analogs of Inta Fm. and Pechora Series 73 - Sandyvey area. Analogs of Inta Fm. and Pechora Series
74 - Chernaya Rechka borehole. Ekushan and Telwiss Fms.

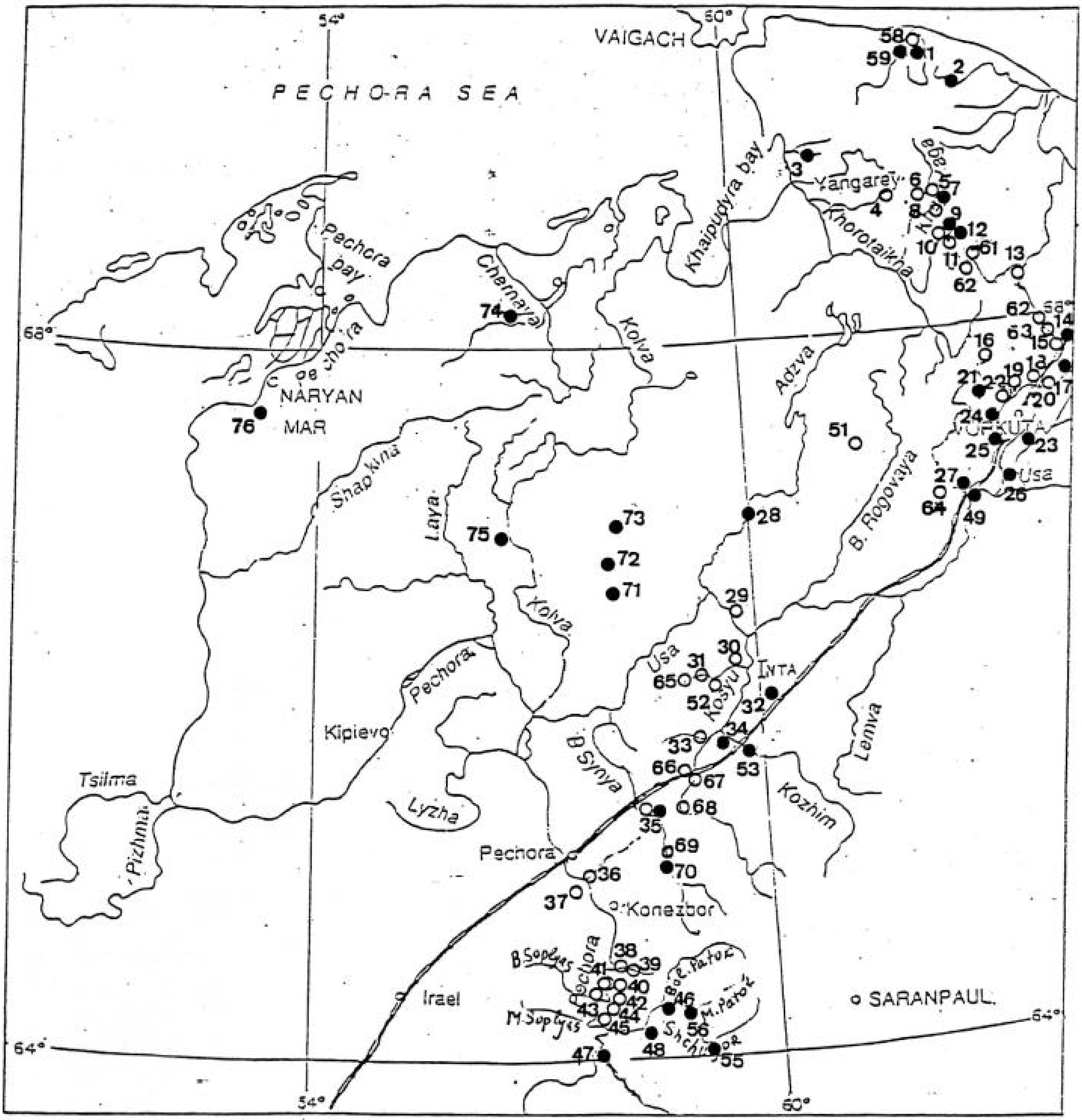
Locality of Permian plants according to Dedeev et al., 1993:
75 - Kharyaga area. Ekushan and Telwiss Fms.

Locality of Permian plants according to Bogomasov, Makedonov, Gorsky, Guseva, Kashevarova, Vladimirovich and Faddeva, 1984:
76 - Naryan-Mar area. Kachgord, Ekushan and Telwiss Fms.

I.A. Dobruskina
Institute of Earth Sciences
Hebrew University of Jerusalem
Givat Ram, Jerusalem 91904
Israel

M.V. Durante
Geological Institute of USSR
Academy of Sciences
Pyzhevsky 7, Moscow 17
Russia 109017

Figure 1.



Permian plant localities in the Northern Cisural. Made by I.A. Dobruskina and M.V. Durante, 1994.

o Upper Permian • Lower Permian

18. PERMIAN PLANT LOCALITIES IN THE SOUTHERN CISURALS (see Fig. 1, p. 28)

LOWER PERMIAN
Localities of the Asselian stage
1 - Aidaralash village near Aktyubinsk. Kholodny Log Formation, Asselian (Vladimirovich, 1986a).
2 - Beltushka village. Shikhany Formation, Asselian (Vladimirovich, 1986a).

LOWER PERMIAN
Localities of the Sakmarian stage
3 - Aktasty River. Sterlitamak horizon, Sakmarian (Vladimirovich, 1986a).
4 - Bolshoy Ik borehole 20, Aktyubinsk area. Sakmarian ? (Vladimirovich, 1986a).

LOWER PERMIAN
Localities of the Artinskian stage
5 - Bolshoy Ik River basin, the Syuren River near farm Dmitrievka. Aktasty horizon and Baygendzhinsk horizon, Artinskian (Vladimirovich, 1981).

LOWER PERMIAN
Localities of the Kungurian stage
6 - South Bashkiria, West Syntas. Philippovo horizon, Kungurian (Vladimirovich, 1986).
7 - South Bashkiria, Abzal section. Kungurian (Vladimirovich, 1986).

UPPER PERMIAN
Localities of the Ufimian stage
8 - Akshat village, Aktyubinsk area. Akshat Formation, Ufimian (Vladimirovich, 1986).

UPPER PERMIAN
Localities of the Kazanian stage
9 - Bekechevo, the Nakyz River. Upper Kazanian substage (Konkov, 1967).
10- Staroseika, the Bolshoy Ik River, basin of the Sakmara River. Lower Kazanian and Upper Kazanian substages (Konkov, 1967).
11- Davletkulovo, Yushatyr River basin. Upper Kazanian substage (Kuleva, 1974).
12- Zheltoye, southeast of Bolshoy Ik River mouth. Upper Kazanian substage (Kuleva, 1974).
13- Aktivnoye, south-southeast of Bolshoy Ik River mouth. Upper Kazanian substage (Kuleva, 1974).
14- Opanasovsky gully, 6.6 km northeast of Imangulovo. Upper Kazanian substage (Meyen, 1971).

UPPER PERMIAN
Localities of the Lower Tatarian substage
15- Bekechevo, the Nakyz River. Lower Tatarian substage (Konkov, 1967).
16- Tuyumbetovo, the Bolshoy Ik River, basin of the Sakmara River. Lower Tatarian substage (Konkov, 1967
17- Kichkas. Amanak Formation, Lower Tatarian ? substage (Minikh et al., 1992).

UPPER PERMIAN
Localities of the Upper Tatarian substage
18- Chernigovsky, left bank of the Nakyz River, basin of the Sakmara river. Upper Tatarian substage (Gomankov and Meyen, 1986).
19- Aleksandrovka, 6 km north of Troizky, the Bolshoy Ik River, basin of the Sakmara River. Upper Tatarian substage (Gomankov and Meyen, 1986).
20- Vyazovka (51 km east-southeast from Orenburg). Upper Tatarian substage (Gomankov and Meyen, 1986).
21- Novokulchumovo, the Sakmara river in Saraktash region. Upper Tatarian substage (Gomankov and Meyen, 1986).
22- Blumental in Burtya region. Upper Tatarian substage (Gomankov and Meyen, 1986).

I.A. Dobruskina
Institute of Earth Sciences
Hebrew University of Jerusalem
Givat Ram, Jerusalem 91904
Israel

M.V. Durante
Geological Institute of USSR
Academy of Sciences Pyzhevsky 7, Moscow 17
Russia 109017

19. PERMIAN OF EAST YAKUTIA

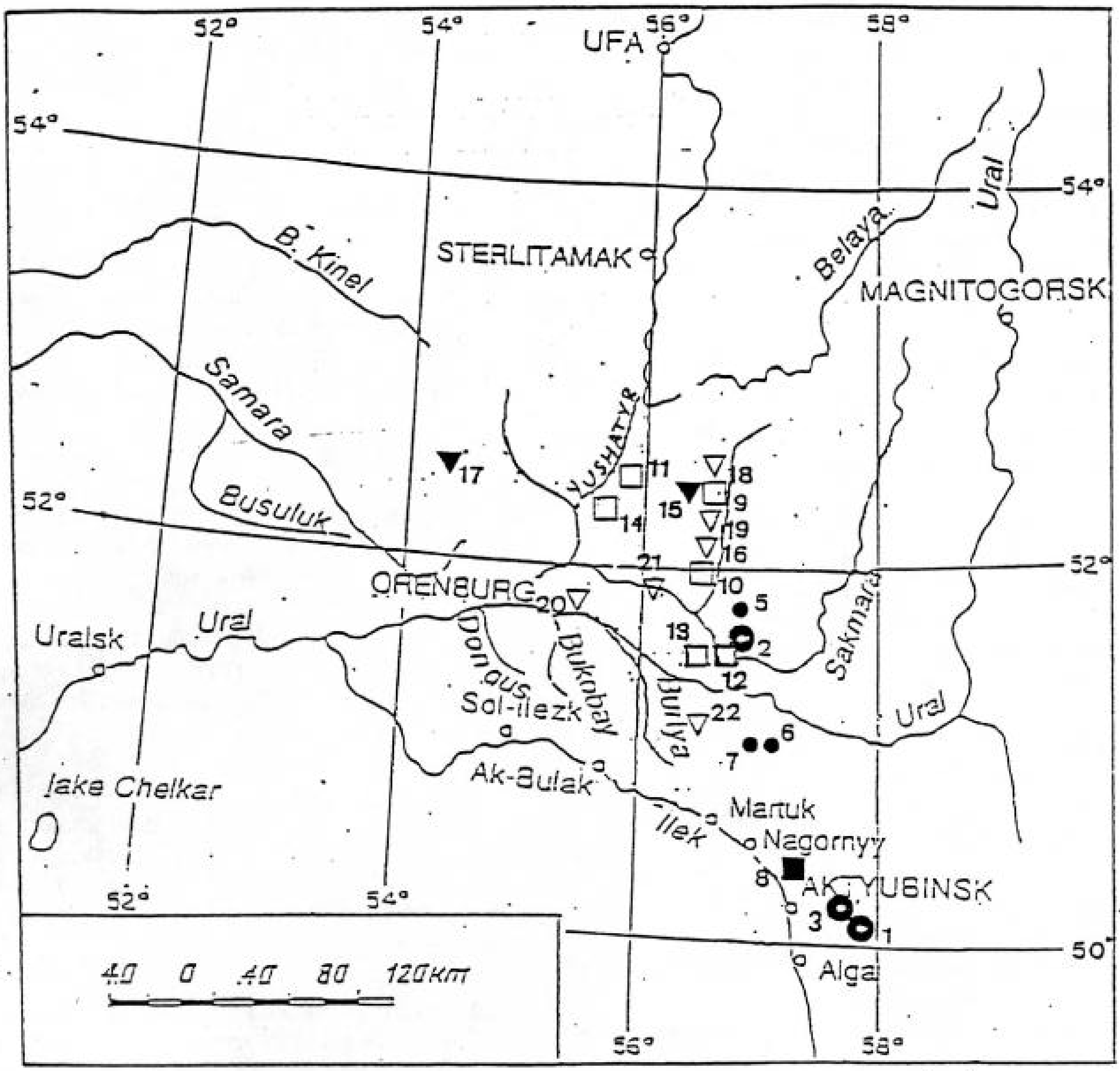
In Western Verkhoyan it is possible to correlate successions containing Angara paleoflora complexes and marine boreal faunas and to date Upper Paleozoic deposits containing floras derived from Angara.

The Verkhoyan paleobasin is in a unique geographical position. To the west it borders the East European paleobasin, where Russian stratotypes for the Carboniferous and Permian systems occur. To the south it is adjacent to areas where Boreal and Tethyan faunas are developed. Therefore, the region is important for comparing three coexisting International Scales, that is, the East European, North American and Tethys scales. Permian ammonoids from Verkhoyan were first described by Y.N. Popov (1964). Subsequent ammonoid work by Ruzhenzev (1975) provided important correlations between Verkhoyan and indeed all of Northeast Asia with standard successions elsewhere in the world. Still later, important ammonoid research was conducted by V.N. Andrianov and his last monograph, published in 1985, has become a standard reference. Therein, ammonoids from five complexes were described (Fig. 1).

In the Kharaulak Anticlinorium of northern Verkhoyan, diverse forms of *Bulunites, Metapronorites, Agathiceras, Tabantalites,* as well as early representatives of *Metalegoceras,* occur indicating an Asselian-Sakmarian age.

In the Echian complex representatives of *Uraloceras* and *Paragastrioceras,* suggest the presence of both Sakmarian and Artinskian strata.

Figure 1



Permian plant localities in the Southern Cisurals

▽ of the Upper Tatarian

■ of the Ufimian

▼ of the Lower Tatarian

● of the Kungurian and Artinskian

□ of the Kazanian

⭘ of the Sakmarian and Asselian

The Tumarin complex is characterized by abundant and diverse representatives of *Tumaroceras*. Representatives of *Neouddenites, Paragastrioceras, Epijuresanites* and *Popanoceras* are less common but suggest a Kungurian age. The complex can be divided into two subcomplexes, the first of which is characterized by *Tumaroceras yakutorum* Ruzh., and the second by *Tumaroceras kashirzevi* Andrianov.

The Cherkambalian (Delendjinian) complex, contains the goniatites *Sverdrupites, Pseudosverdrupires* gen. nov., *Daubichites*, *Anuites* and *Popanoceras* and is thought to be of Roadian age.

The Dulgalahsky (Imtachanian) complex is characterized by *Mexicoceras* (*Paramexicoceras* Popo) in the Imtachan suite and by the ceratite *Kingoceras ?* from the Upper Dulgalach subsuite in Western Verchoyanye. The age of this complex is determined to be Abadehan - Dzhulfian.

Brachiopods, represented mainly by Siberian species are the most widespread benthic group in the area and permit one to subdivide sections into biostratigraphic units. At some stratigraphic levels, usually intervals indicative of maximum transgression, brachiopods are generally of Boreal aspect and enable wide correlations to be made from the Urals in the west through Taimir in the Northeast, through to the Far East and to Mongolia in the south.

Igor V. Budnikov
Siberian Research Institute of Geology
Geophysics and Mineral Resources
Novosibirsk, Russia

Aleksandr G. Klets
United Institute of Geology
Geophysics and Mineralogy
Novosibirsk, Russia

Vitaly S. Grinenko State
Yakutsk Exploration-Survey Expedition
Yakutsk, Russia

Ruslan V. Kutygin
Institute of Geology
Yakutsk, Russia

20. RADIOMETRIC (SEGKNP) DATES FOR SOME BIOSTRATIGRAPHIC HORIZONS AND EVENT LEVELS FROM THE RUSSIAN AND EASTERN AUSTRALIAN UPPER CARBONIFEROUS AND PERMIAN

Estimates of the duration of the Permian System have remained speculative since its inception in 1841: they have ranged from 32.5 to 56 Ma (Menning, 1995). The reason for such speculation is simple: no rocks from the reference areas, particularly on the Russian platform and in the Urals, have been studied using radiometric techniques. The current boundaries for the Permian period, with the base at 298 Ma and top at 251 Ma, are derived respectively, from successions in Germany (see Roberts et al., 1995) and China (Claoué-Long et al., 1991). Correlation between these areas and Russian standard sections, where the Permian was originally defined, is reliant on fossil faunas and flora, the results are often tenuous and highly speculative, because data is derived from marine and nonmarine palaeoenvironments, as well as very different palaeoclimatic regimes.

Despite the lack of reliable age data for the Permian, there is an urgent demand for accurate radiometric ages, particularly for application in computer driven geological modelling. Currently applied dates for the Permian (e.g., Harland et al., 1990), are little more than guess work, often made to appear respectable by best fit models of spurious data. What is lacking are biostratigraphic constraints for dated samples, and the application of appropriate analytical techniques to tuff samples, and the application of appropriate analytical techniques. The development of high resolution ion microprobe (SHRIMP) dating method, analysing U/Pb from selected parts of individual zircon crystals, has improved accuracy and precision greatly, with errors of one per cent. Our studies apply, SHRIMP techniques to tuff samples from fossiliferous type localities from the Russian Upper Carboniferous and Lower Permian of southern Urals and eastern Australia (see Foster et al., 1996).

Tuff samples were collected by G. Mizons from key sections of the Carboniferous and Lower Permian flysch deposits which crop out in the southern Urals, Russia (Fig. 1). Each sample is biostratigraphically constrained by either marine microfossils (e.g., small foraminifers, fusulinids, radiolaria or conodonts) or megafauna, such as ammonoids, brachiopods. Table 1 give the biochronological relationship between these samples. Analytical details of the SHRIMP dating will be discussed elsewhere by Dr. Claoué-Long, together with tabulation of the complete isotopic data.

Biostratigraphic control

Locality data and brief field description for each samples reported here are given below and in Figures 1-4, Plate l. Four samples were derived from reference areas for the Russian Carboniferous and Permian. The fusulinid zonation referred to are those used in the European Russia and in the Urals.

a. Late Moscovian stage, uppermost part of Myachkovskian horizon; zone *Fusulinella bocki*. Sample 1822-6 (51’05’N; 75’35’E). The section crops out on the left bank of the Ural River, 32 km

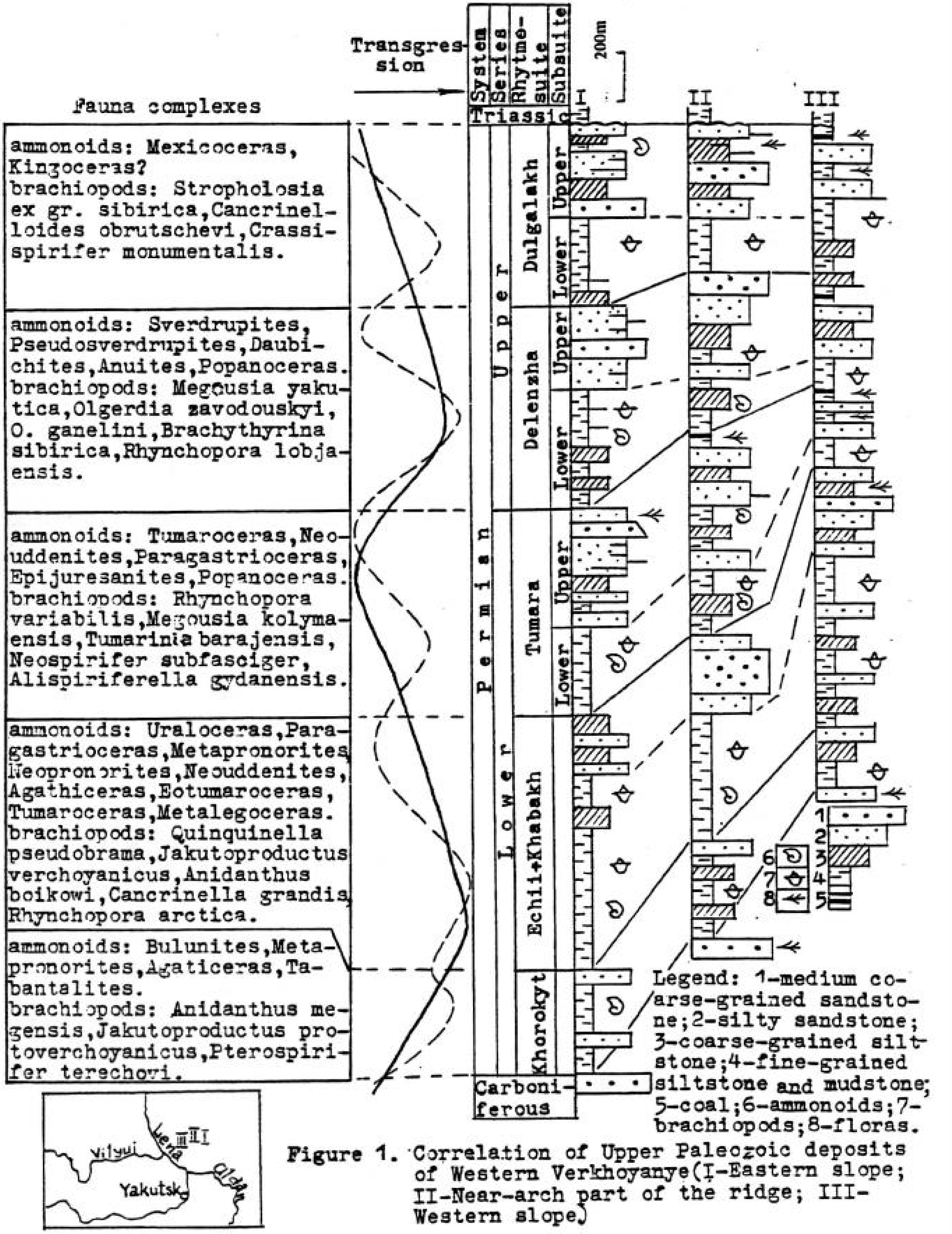


Figure 1. Correlation of Upper Paleozoic deposits of Western Verkhoyanye (I-Eastern slope; II-Near-arch part of the ridge; III-Western slope)

south of the town of Mednogorsk. The tuffs form a band about 11 m thick, within a sequence of sandstone and conglomerate. The gravelstone bed with numerous fusulinids there is in 30 m below of tuff bottom. Fusulinids *Schubertella inflata* Raus., *Fusulinella bocki* (Moeller), *F.* ex gr. *colaniae* Lee et Chen, *Pulchrella pulchra* (Raus. et Bei.), *Fusulina elegans* Raus. et Bel., *F. forrissima* Raus., *F.* cf. *kamaensis* Saf., *PutreIla brazhnikovae* (Putrya) were defined in this bed. 'Ihe tuff level could be adopted as the lower boundary of Late Carboniferous. The next fauna bearing sandstone bed occurs 250-300 m stratigraphically above the tuff band. Fusulinid assemblage of one belongs to the *Jigulites jigulenses* zone of Gzhelian stage.

b. Lower Permian - mid Asselian stage- *Sphaeroshwagerina moelleri - Pseudofusulina fecunda* zone. Sample 1580-17 (53'55'N; 56'35'E) is taken from the Kholodnoloshskian Horizon (Bed 17) Krasnousolsk section, Usolka River. Within Bed 17, which is 2.1 m thick; the tuff layers are interbedded with an altemating sequence of argillaceous limestone, and greenish grey argillaceous marls (Chuvashov et al., 1993, **p.** 60).

Ammonoids are represented by *Artinskia* sp., *Neopronorites tenuis* (Karp.), *Neoglaphyrites satrus* Max., *Agathiceras uralicum* (Karp.), *Juresanites* aff. *primitivus* Max., *Prostacheoceras juresanensis* Max., *Tabantalites* sp. there are immediately below of Bed 17. Bed 18 contains an ammonoid assemblage of *Neopronorites tenuis* (Karp.), *Artinskia nalivkini* Ruzh., *Agathiceras uralicum* (Karp.), *Svetlanoceras* sp. nov. The interval of Bed 17-20 belongs to conodont *Streptognathodus constrictus* Zone. Within Bed 24 (8.5 m above Bed 17) there are numerous fusulinids of *Sphaeroschwagerina sphaerica* **-** *P. prma* Zone.

c. Lower Permian **-** top Sakmarian stage **-** *Pseudofusulina uralensis* Zone. Sample 1727-233 (55'N; 57'40'E) from the Sim River section, is taken from a quarry, 120 km east of Ufa-City. Beds of 9-12 within the upper 5.6 m of the section, consists of alternating blue-grey fine- grained sandstone and dark argillites; they are flysch deposits which show turbidite bedding. A thin interlayer of light greenish-grey tuff is present in the uppermost part of this sequence. Late Sakmarian ammonoids *Agathiceras uralicum* (Karp.), *Neopronorites tenuis* Karp., *Thalassoceras multifidum* Ruzh., *Propopanoceras incallidum* (Ruzh.) and conodonts of *Neogondolella bisselli* Zone are defined 22 and 20 m below of the tuff level; 50 m above one there are fusulinids of *Pseudofusulina pedissequa* Lower Artinskian Zone (Chuvashov et al., 1990).

d. Lower Permian - base Artinskian stage *Pseudofusulina pedissequa* Zone. Sample 1630-45-70 (53'N; 56'35'E) was collected 341 m above the bottom of Artinskian stage within a thick up to 1076 m Lower Artinskian flysch sequence of the Belay River section (Chuvashov et al., 1993, p. 94). The tuff layers are 1- 12 cm thick, alternating with finely detrital limestones containing small foraminifers, sponge spicules, brachiopod shell fragments, bryozoans and very small ammonoids. The argillites contains radiolarians and ammonites. Fusulinids of Burtsevskian Horizon *Pseudofusulina vissarionovae* Raus., *P. pedissequa* Viss., *P. urdalensis* Raus., *P. praesubstricta* Zol. et Mor., *P.* ex gr. *confusa* Raus., *P. prima* Mor. et Ogneva, *P. ovata* Raus. are 100 m below

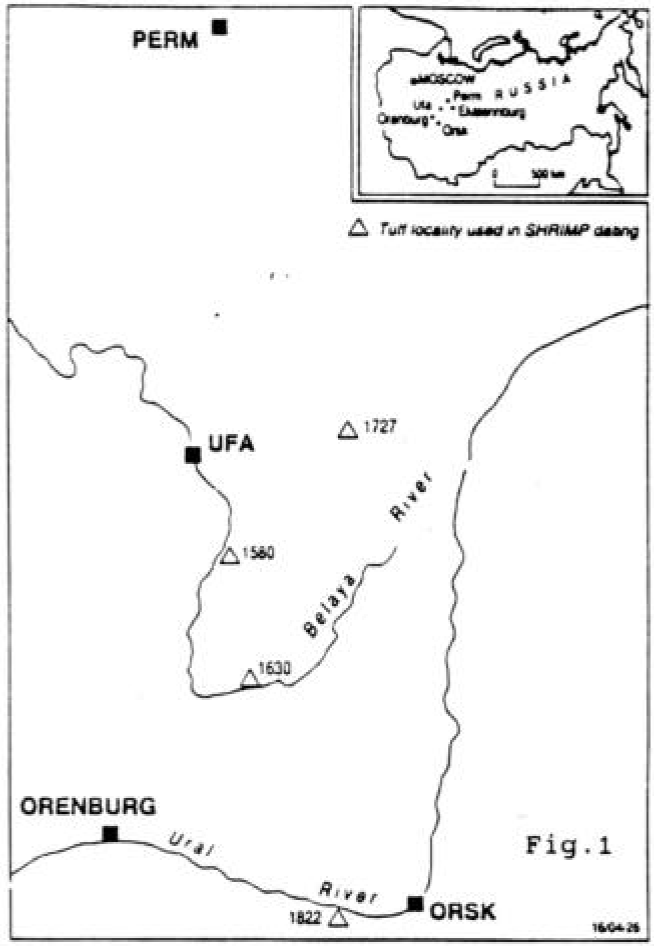


Figure 1. Locality map of southern Urals, showing tuff sample sites.

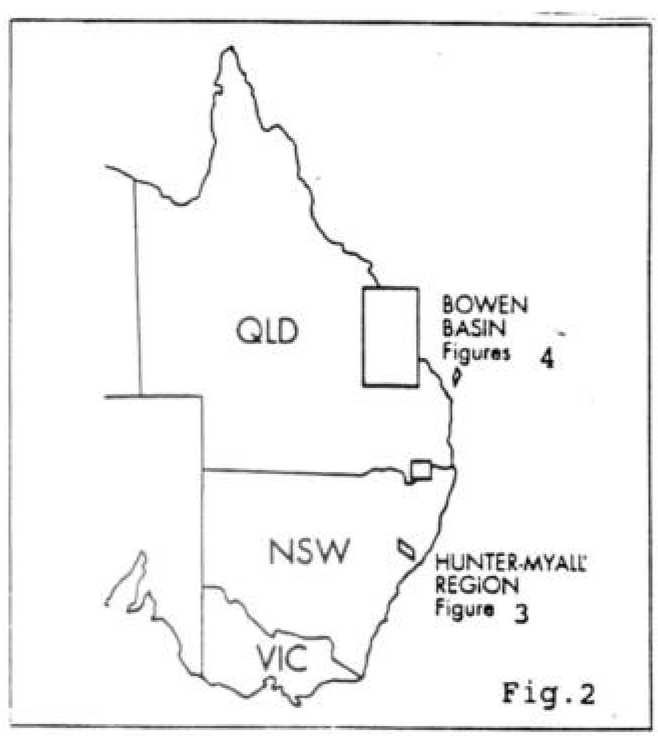


Figure 2. Location the Bowen Basin, Border Rivers and Hunter-Myall region in eastern Australia.

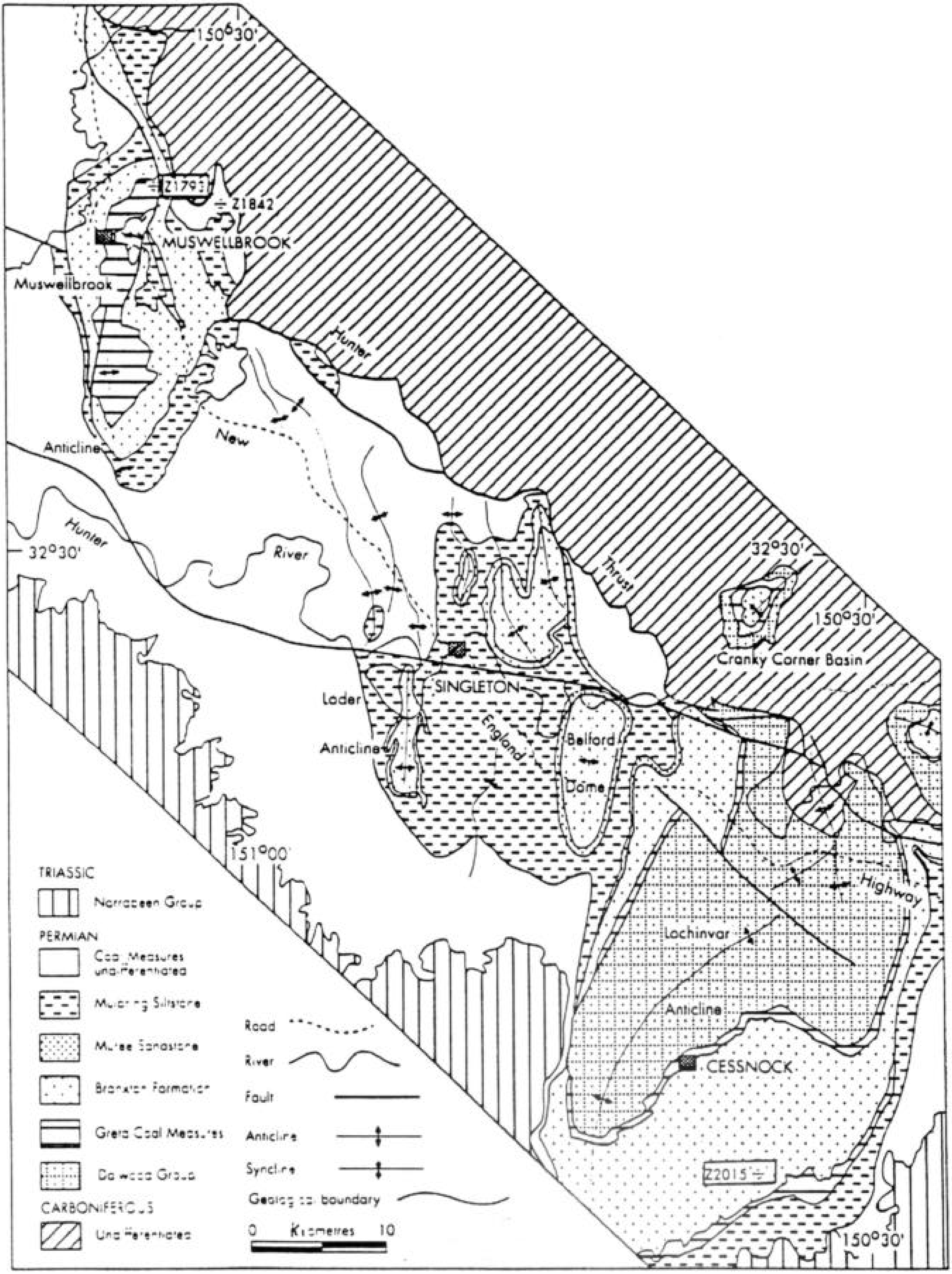


Figure 3. Geological map of the lower Hunter River region of the Sydney Basin giving location for SHRIMP samples (box outline) from the Greta Coal Measures, Mulbring Siltstone and Branxton Formation.

Plate I. CORRELATION OF RADIOMETRICAL AND BIOSTRATIGRAPHICAL SCALES OF PERMIAN SYSTEM

		Duration Ma	
KAZANIAN			
			253,4 +- 3,2 Ma
UFIMIAN	Sheshminskian horizon	10,7	
			264,1+- 2,2 Ma
KUNGURIAN	Bairdia plebeia	1	
KUNGURIAN	Acratia similaris	4	
KUNGURIAN	Paraparchites humerosus		
KUNGURIAN	Bairdia reussiana	1	
			272,2+- 3,2 Ma
ARTINSKIAN	Parafusulina solidissima	2	
ARTINSKIAN	Pseudofusulina juresanensis	4	⊘
ARTINSKIAN	Pseudofusulina pedissequa - P.concavutas	2	⊘ 280,3 +- 2,4 Ma
SAKMARIAN	Pseudofusulina urdalensis	2	280,3 +- 2,6 Ma
SAKMARIAN	Pseudofusulina verneuili	1	
SAKMARIAN	Pseudofusulina moelleri	2	
ASSELIAN	Sphaeroschwagerina sphaerica- Pseudofusulina firma	2	⊘
ASSELIAN	Sphaeroschwagerina moelleri- Pseudofusulina fecunda	3	
			290,6 +- 3,0 Ma
ASSELIAN	Sphaeroschwagerina fusiformis	1	
ASSELIAN	Daixina bosbytauensis- Daixina robusta	1	
GZHELIAN	Daixina sokensis	~ 4	⊘
GZHELIAN	Jigulites jigulensis		
GZHELIAN	Triticites stuckenbergi		
KASIMOVIAN	Triticites arcticus- T. acutus	~ 4	
KASIMOVIAN	Montiparus montiparus		
KASIMOVIAN	Protriticited - Obsoletes		
			300 +- 3,2 Ma
MOSCOVIAN	Fusulinella bocki		

(heavy box) - Uralian data

(thin double box) - Australian data

⊘ - Uralian samples in progress

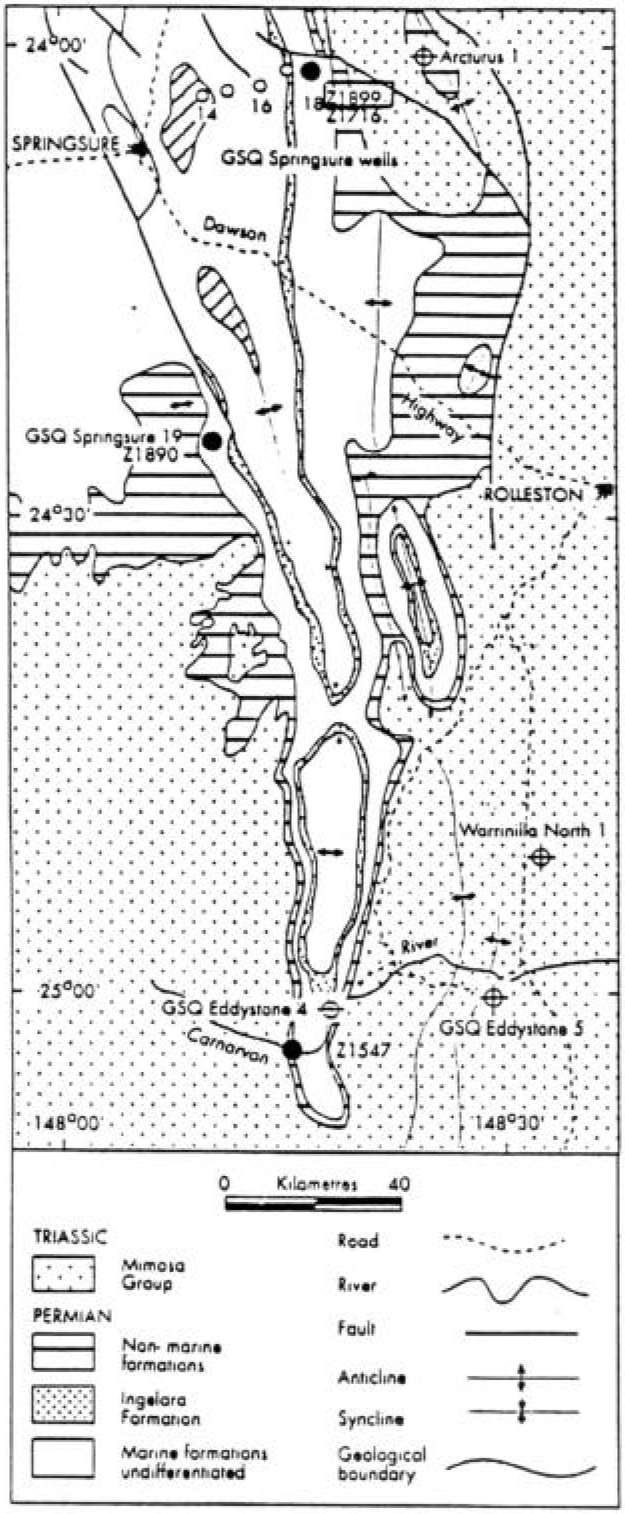


Figure 4. Geological map of the Denison Trough, Bowen Basin, giving the location of SHRIMP samples from the Ingolara Formation (in box outline).

of the tuff level.

Some SHRIMP zircon dates from Permian ignimbrites and tuffs associated with fossiliferous strata within Sydney-Bowen Basin and New England Orogen (Plate 1, figs. 2-4) are used to establish a timescale for the Permian System in eastern Australia. The some levels only which could be correlated with Uralian stratotype boundaries are given below.

e. The Branxton Formation, a unit of sandstone, siltstone, conglomerate and rare tuffs, was deposited as the result of marine transgression which onlapped the top of the Greta Coal Measures. The lower part of the Branxton Formation contains brachiopods, bryozoans, palynofloras. The ammonoid *Neocrimires meridionalis* (Teichert and Fletcher, 1943) *Aricoceras meridionalis* after Leonova et Bogoslovskaya (1990) is present in the Branxton Formation near Farley. *Aricoceras meridionalis* is considered, after Leonova and Bogoslovskaya, as the immediate successor of the Uralian *Neocrimites* (Sarginskian Horizon of Artinskian stage) evolution.

Sample 72015 from Branxton Formation, taken at a depth of 558.5 m in southland Kalingo DDH 18 at GR 354572 near Ellalong NSW (Fig. 3), comes from brown to buff tuffaceous siltstone 12 m above the top of the Greta Seam, the uppermost seam in the Greta Coal
Measures in that part of the Lochinar Anticline. The age of 31 analysed crystals is 272.2 + 3.2 Ma. This level will correspond to Saraninskian Horizon of the Urals.

f. The Mulbring Siltstone on the northern Sydney Basin is a succession of grey siltstone and minor claystone which conformably overlies either the Muree Forrnation, or the Branxton Formation where the Muree Formation is not separately recognised. The sedimentation of conglomerates and sandstone of the Muree Formation reflected a very important episode of the Middle Permian regression which may be coeval to grandiose Middle Ufimian rey'ession of the Northern Hemisphere.
Sample Z1793 is from tuffs at 129.90 m within Mulbring Formation in MCC Lupton Park DDH8, drilled at GR105290, 2 km north of Muscle Creek, east of Muswellbrook (Fig. 3). Age of 34 from 40 analysed zircon grains is 264.1 + 2.2 Ma.

g. Ingelara Formation within the Denison Trough in the western Bowen Basin, central Queensland (Figs. 2, 4), consists of thinly bedded micaceous to calcareous silty mudstone and mud-rich sandstone, which is extensively bioturbated, locally rich in shelly fossils, and also contains erratic cobbles and ash bands. It is part of a thick and essentially continuous clastic succession extending throughout most of the Permian system.

The dated samples of the Ingelara Formation were taken from GSQ Springsure 18 in the northern part of the Denison Trough (Fig. 4). Biostratigraphic control of the Ingelara Formation with GSQ Springsure 18 is provided by foraminifera, palynoflora and sparse marine fossils. Of greatest importance is the identification of the *Pseudonodosaria borealis* Zone. Within the foraminiferal assemblage, *P. borealis* occurs with *Nodosaria krotovi, N. noinski, Frondicularia bella*, an association diagnostic of the Kazanian stage, and there is a total of 12 species common with early Late Permian Kazanian assemblages from Arctic Russia and adjacent area (Palmieri et al., 1994).

Sample Z1899 comes from a pale grey-green tuff at a depth of between 480.75 and 480.83 m in Springsure 18. A dominant population of 28 zircon grains has a mean age 253 + 3.2 Ma.

New SHRIMP ages from South Urals and Australia presented in this paper now allow accurate correlation of some biostratigraphical and events level to be made between two continents and, by another words, between Gondwana and Northern hemisphere. The exact duration of stages and biostratigraphical zones could be defined using the new reported SHRMP ages. One of the major applications of the new timescale will be in the determination of rates of deposition within different sedimentary basins. More research is continuing, using Arabian and Australian material.

Acknowledgments

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Chuvashov, B.I.*
Foster, C.B.**
Mizens, G.A.*
Roberts, J.**'
Claoué-Long, J.C.**

*Institute of Geology and Geochemistry
of the Urals Branch of Russian Academy of Sciences
620151 Ekaterinburg, Russia

**Australian Geological Survey Organization
GPO, Box 378 ACT 2601, Australia

***Department of Applied Geology
University of New South Wales
Sydney NSW 2052

21. CONODONT FAUNA FROM THE PERMIAN- TRIASSIC BOUNDARY: OBSERVATIONS AND RESERVATIONS

In two recent studies, the author *(in* Orchard et al., 1994; Krystyn and Orchard, in press) has described the conodont faunas from *Otoceras* bearing beds in Selong, Tibet and from several sections in Spiti, India. Three conclusions drawn from these studies and from a survey of the literature are:

a. *Neogondolella* faunas of the Changshingian and Griesbachian stages can be distinguished and have few, if any, species in common.

b. *Hindeodus latidentatus,* the supposed predecessor of *Isarcicella parva,* is confined to the upper Dorashamian and upper Changshing Limestone. Most records of *H. latidenratus* (emend.) from higher stratigraphic levels are referred to *Hindeodus* n. sp. X.

c. Paleoenvironmental factors exerted a significant influence on the appearance and relative abundance of *Neogondolella* and *Hindeodus (+Isarcicella)* species.

In this paper, conodont succession about the Permian- Triassic boundary in some key localities are reviewed in the light of taxonomic revisions of Griesbachian conodont fauna, and observations on conodont biofacies.

Taxonomic status

A preliminary taxonomy of Permian-Triassic boundary conodonts has been presented recently by Orchard et al. (1994), and a summary of the distribution of additional Griesbachian taxa is presented by Krystyn and Orchard (in press). The description of Spiti species is in preparation.

The characteristic conodont fauna of the Changshing Limestone (not all co-occurring) is: *Neogondolella subcarinata* (2 morphotypes, Orchard et al., 1994), *N. wangi, N. postwangi, N. orientalis, N. changxingensis, "N. deflecta", N. xiangxiensis, N. sosioensis, N.* n. sp. A, Orchard 1994; *Hindeodus latidentatus, H. typicalis.*

In contrast, the Griesbachian faunas of Selong and Spiti contain the following (not all co-occurring): *Neogondolella* ex gr. *taylorae, N,* ex gr. *tulongensis, N.* aff. *changxingensis, N.* aff. *carinata, N. carinata, N. planata, N. nevadensis, N. meishanensis, N.* n. sp. A, B, C, D, E of Orchard (see Krystyn and Orchard, in press); *Hindeodus* n. sp. X (see Krystyn and Orchard, in press), *H. typicalis, IsarciceIla parva, ?I. turgida, I. isarcica.*

Some comments on generic nomenclature. For now, *Neogondolella* is preferred over both *Gondolella* (restricted to Late Carboniferous species) and *Clarkina* (insufficiently defined). Use of the latter genus is deferred until a fuller understanding of multielement apparatuses and phyletic relationships are established for the entire range of Late Permian and Triassic neogondolellids.

Amongst *Hindeodus* and its derivatives, all specimens with a conspicuously elevated cusp, equi-dimentional mid-blade denticles, and abruptly terminated posterior margin thickened lateral margins - accessory nodes, are here referred to *Isarcicella.* This includes both *I. parva* and *I. turgida.* These morphological criteria provide an adequate basis for recognizing a separate genus, particularly when it is of chronostratigraphic importance (cf. *Chiosella).* Multielement considerations are not obviously in conflict with this classification, in spite of the apparatus of *I. parva* being like that of *Hindeodus* (Kozur, 1995); many genera distinguished by reference to platform morphology have similar apparatuses. The appearance of the genus *Isarcicella* of this scope would provide a suitable datum for the base of the Triassic.

Conodont biofacies

It has long been understood (e.g., Druce, 1973) that, throughout the Permian and beyond, *Neogondolella* is more common in offshore, deeper, and/or cooler water marine environments, whereas *Hindeodus* and its antecedents flourished in the near-shore, shallower, and/or warmer regions. Although neither the precise environmental controls nor indeed the habitats of conodont animals are fully understood, the relative distributions are well established. Fortunately, the faunal partitioning is not absolute and so in many collections elements of both biofacies will be present, allowing calibration of the two faunal successions. However, in some conodont collections only one biofacies is represented. Examples of such faunas are to be found in the Alpine carbonate successions (Schonlaub, 1991), which are wholly a *Hindeodus (+Isarcicella)* biofacies fauna, and in Permian oceanic radiolarian cherts where *Neogondolella* occurs alone (Orchard, 1986).

The impact of biofacies on the correlation of Permian- Triassic boundary sections has been largely ignored in previous studies, partly because *Isarcicella* species are widespread and have been reported from several important sections. However, *Isarcicella* is rare in *NeogondoleIla* dominated faunas such as those at Selong and Spiti (Orchard et al., 1994; Krystyn and Orchard, in press), so their occurrence has been previously disputed. The extent to which the occurrence of *Isarcicella* may be influenced by paleoenvironmental factors is discussed below. The following summarizes the dominant biofacies in the Griesbachian of several key sections:

1. **Spiti** - *Neogondolella dominates. Minor Hindeodusl Is.*
2. **Selong** - *Neogondolella dominates. Minor Hindeodusl Is.*
3. **Kashmir** - *Hindeodusl Is. dominates, replaced by Neogondolella*
4. **Meishan** -*.Neogondolella dominates, replaced by Hindeodusl Is.*
5. **Alps** - *Hindeodusl Is. exclusively.*
6. **Arctic** - *Neogondolella dominates. Minor Hindeodusl Is.*

Guryul Ravine, Kashmir

As documented by Matsuda (1981, Table 1), conodont faunas from Guryul Ravine are sparse in the lower Khunamuh Formation: member El has produced only 5 elements, including both *1Veogondolella carinata* and *Hindeodus* sp. In member E2, no conodont elements are recorded with the first *Otoceras* (beds 52-53), but an exclusive *Hindeodus* biofacies is represented by the first conodonts that appear above, in bed 55. *NeogondoleIla* reappears and becomes common in the upper part of E2 through E3 (beds 59-64) concomitant with a marked decline in *Hindeodus*.

About 30 cm above bed *55*, bed 56 contains *IsarciceIla* sp. and *I. parva* (Matsuda, 1981), which represents about 7 per cent of a fauna dominated by *Hindeodus typicaIis*. In smaller succeeding collections in which it occurs, *Isarcicella* represents about 3 per cent of the total. Based on these ratios, 1-3 elements of *1. parva* might be expected in the documented collection from bed 55, assuming it was extant. Larger collections are needed to resolve the possibility of collection failure, particularly in view of the presence of a specimen very close to, if not conspecific with *l. isarcica* in bed 55 (Matsuda, 1981, Plate 5, fig. 8). *Neogondolella* is presumably absent from beds *55* and 56 for environmental reasons. A *IsarcicelIa parva* datum drawn at the base of bed *56*, as would be dictated by the proposed GSSP (Yang et al., 1995), would be poorly constrained from below. It would also have the effect of assigning *Otoceras woodwardi* beds to the Permian, for which no supporting conodont evidence exists. Furthermore, the sparse data from member El is suggestive of Griesbachian age.

Meishan, China

Several additional papers and many additional illustrations of conodonts from the Permian-Triassic transition beds at Meishan have become available recently. From these, and earlier reports, it appears that transition bed 1 (beds 25, 26 880, 881) contains conodonts of a predominwt *Neogondolella* biofacies, as does the underlying Changhsing Limestone. In contrast, above the base of transition bed 2 (bed 27) the *Neogondolella* biofacies becomes increasingly replaced by a *Hindeodus* biofacies (Zhang, 1987, Table 1; Wang, 1995a, Table 2). The Permian-Triassic boundary has been proposed within the "monofacies" bed 2, where *Isarcicella parva* reputedly evolves from *Hindeodus latidentatus*, and "Permian" *Neogondolella* species disappear (Wang, 1995b; Yang et al., 1995).

The *NeogondolelIa* fauna of the transition beds below the *Isarcicella parva* datum has been compared repeatedly with that of the Changshing Limestone, in spite of generally sparse numbers and its fragmentary nature. The character of this *Neogondolella* fauna is not yet fully resolved. Amongst the illustrated specimens from Meishan, several resemble species from the Griesbachian *taylorae* Zone (Krystyn and Orchard, in press) rather than those from the Changshing Limestone. For example, some specimens resemble *Neogondolella* ex gr. *taylorae* (Wang, 1994, Pl. 1, figs. 12, 13; 1995a, Pl. 1, figs. 5, 8, 9, 13) and *N. tulongensis* (Wang, 1994, Pl. 1, fig. 14; 1995a, Pl. 1, fig. 12). The occurrence of *Neogondolella meishanensis* Zhang et al. (1995) in the lower transition bed is particularly notable. Each of these taxa occur throughout the Griesbachian of Spiti (Krystyn and Orchard, in press) and are now recognized also from Selong. Wang (1995a) did not record *Hindeodus* (or *Isarcicella)* species below bed 27, but showed three species appearing at the base of that bed, and another three, including *I. parva*, appearing midway through the bed. A seventh species, *I. turgida* appeared higher still, although *I.* cf. *turgida* is illustrated (but not tabulated) from lower bed 27 (Wang, 1994, 1995a). This flourish of *Hindeodus- Isarcicella* species emphasizes the biofacies change that begins at the base of bed 27 and becomes more pronounced upsection through the sampled Yinkeng Formation. This change is not evident from the work of Zhang et al. (1995) because no numeric data is presented, but a form identified
as *Hindeodus latidentatus* from bed 25 is illustrated (op. cit., Pl. 2, fig. 12). This specimen has a large, high cusp and abruptly terminated posterior carina - although some separation of the posterior denticles is apparent, the former attributes suggest closer affinity to *Isarcicella parva* than to *H. latidentatus*. A specimen from upper bed 27 assigned to *H. latidentatus* (Wang, 1994, Pl. 1, fig. 9) is an example of *Hindeodus* n. sp. X (see Krystyn and Orchard, in press).

Of the other *Hindeodus* and/or *Isarcicella* species recorded from the transition beds at Meishan, a characteristic species that occurs both beneath and above the proposed GSSP, but not in the Changshing Limestone, is *Hindeodus changxingensis*, in which the author would also include *H. julfensis* sensu Wang (1994, Pl. 1, fig. 11; 1995a, Pl. 3, fig. 1). *Hindeodus julfensis* sensu stricto is a Dzhulfian species.

In summary, both lower and upper boundary beds 1 and 2 (beds 25-27; beds 880-882) at Meishan appear to contain a conodont fauna that differs from that of the Changshing Limestone. It does contain several elements characteristic of Griesbachian strata at both Selong and Spiti. At Meishan, *Otoceras?* sp. (in bed 26), *Isarcicella* aff. *pawa (-H. latidentarus* sensu Zhang et al., 1995 in bed 25), *I.* ex gr. *turgida* (in lower bed 27+), *Neogondolella* ex gr. *taylorae, N. tulongensis, N. meishanensis* (all in lower boundary bed+), *Hindeodus changxingensis* and *H.* n. sp. X (both throughout bed 27) are all faunal elements that are absent from the Changshing Limestone, but occur in the transition beds both beneath and above the proposed GSSP in bed 27. Each of these taxa are, or could be defined as, indicators of Griesbachian rather than Changshingian time. The rarity (or absence) of *1. parva* below mid transition bed 2 may result from the predominance of a *Neogondolella* biofacies through this interval.

Alps

Schonlaub (1991) and Kozur (1995) have determined and illustrated *Hindeodus latidentatus* from the Tesero Oolite of the Alpine Permian- Triassic succession. In the author's view, these taxa are examples of *Hindeodus* n. sp. X, which postdates the late Changshingian *H. latidentatus* in Meishan. Examples of the new species are also known from the Griesbachian of Spiti and elsewhere (Krystyn and Orchard, in press). This revision is in line with the record of *Isarcicella parva* from the Reppwand outcrop of the Tesero in the Carnic Alps (Schonlaub, 1991), which should therefore be regarded as Griesbachian in age.

Nepal

Conodonts indicative of the *taylorae* Zone have been illustrated by Garzanti et al. (1994a, Pl. 2) from the Manang area of central Nepal. The specimens of both *N. orientalis transcaucasica* and *N. carinata* correspond to *N. taylorae*. Specimens assigned to *Hindeodus latidenratus* emend. are exarnples of *Hindeodus* n. sp. X or, in the case of one specimen from Tilicho, of *Isarcicella parva* (Garzanti et al., 1994a, Pl. 3, fig. 9) Reinterpreted thus, the conodonts show affinity to Griesbachian faunas from Selong and

Spiti, rather than to those from the upper Dzhulfian (as in *N. o. transcaucasica)* or Changhsingian.

Most recently, Belka and Wiedmann (1996) have also illustrated *taylorae* Zone conodonts from the Griesbachian of the Thakkhola region of Nepal, although, in part, they too were assigned to Changshingian species.

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M.J. Orchard
Geological Survey of Canada GSC (Vancouver)
100 West Pender Street
Vancouver, British Columbia V6B 1R8

22. TETRAPOD BIOCHRONOLOGY SUPPORTS THREE-EPOCH PERMIAN

Introduction

Recent proposal to divide the Permian into three epochs (Early, Middle and Late) by Glenister et al. (1992) challenges longstanding tradition of dividing the Permian into two epochs that dates back to the old concept of Dyas. This proposal must have strong merit to override priority. Its strongest value will be if the threefold Permian can be correlated globally, particularly in marine strata which provide the basis for the standard global chronostratigraphic scale. It is also worth considering whether a threefold Permian can be recognized in the nonmarine strata that were deposited across the vast Pangean supercontinent. Here, I argue that tetrapod vertebrates (amphibians and reptiles) provide a strong basis for the recognition of three Permian epochs.

The Permian tetrapod record

Anderson and Cruickshank (1978), Olson (1989), Milner (1990, 1993a) and Olson and Chudinov (1992) provided excellent, up-to-date overviews of the record of Permian tetrapods. The idea that three distinct phases of tetrapod evolution can be recognized in the Permian dates back at least to Romer (1966, Table 2). It has been developed along evolutionary, paleobiogeographic and/or paleoecologic lines by Bakker (1977, 1980), Anderson and Cruickshank (1978), Olson (1989) and Olson and Chudinov (1992). Here, I discuss its biochronological significance.

As extensive and long studied as the Permian record of tetrapods is, it is not without biases and imperfections. For my analysis, most significant is the virtual geographic restriction of Artinskian tetrapods to the western United States and the rarity of Kungurian and Ufimian tetrapods, a very real gap in the record (Milner, 1993a). However, despite this gap-and perhaps accentuated by it-three phases (variously called complexes, chronofaunas, dynasties or empires by previous workers) of Permian tetrapod evolution (Fig. 1) can be identified: (1) Early Permian (Asselian-Sakmarian- Artinskian); (2) Middle Permian (Kungurian-Ufimian-Kazanian); and (3) Late Permian (Tatarian sensu lato). To characterize these three phases I employ recent global compilations of Permian family-level tetrapod diversity by Benton (1993) and Milner (1993b) (Figs. 2-4). Although beset by some problems (see below), these compilations provide a standardized database that delineates the same three phases of Permian tetrapod evolution identified by other means.

Early Permian tetrapods

Most Early Permian tetrapods are holdovers from the Late Carboniferous (Figs. 2-4). They identify a single paleobiogeographic province (the edaphosaurid empire of Anderson and Cruickshank [1978] or the edaphosaur-nectridean province of Milner [1993a]) from the southern region of Euramerica close to the paleoequator. Semi-aquatic temnospondyl amphibians, microsaurs, anthracosaurs, seymouriamorphs, cotylosaurs, a variety of predatory pelycosaurs and the herbivorous pelycosaur Edaphosaurus are characteristic Early Permian tetrapods.

The continuity of tetrapod families from the Carboniferous into the Permian indicates how difficult it is to identify the beginning of the Permian Period using tetrapods. However, the extinction of 26 tetrapod families at or near the end of the Artinskian (truncation of Bakker [1977] dynasty I) makes it easy to identify an Early-Middle Permian boundary. The Kungurian-Ufimian gap in the tetrapod record may in part explain the low number of family originations following this truncation. It emphasizes that knowledge of the Middle Permian phase of tetrapod evolution is almost restricted to the Kazanian.

Middle Permian tetrapods

The first therapsids essentially appeared during the Kazanian, marking what Bakker (1980) aptly termed the ”Kazanian revolution” in tetrapod evolution. The Middle Permian amphibian fauna (Fig. 2) consists mostly of Early Permian holdovers with only a few new appearances. Indeed, by the Kazanian the tetrapod fauna is reptile dominated, whereas during the Early Permian, amphibians and reptiles were almost equally represented. Anderson and Cruickshank (1978) identified the Middle Permian fauna as the first fully terrestrial tetrapod fauna and termed it the tapinocephalid empire.

By the Kazanian, diapsid reptiles had diversified into their two great clades, the lepidosauromorphs (younginids and tangasaurids) and the archosauromorphs (protorosaurids and proterosuchids) (Fig. 3). Synapsid reptiles numerically dominated Kazanian tetrapod faunas (Fig. 4). Especially abundant were the herbivorous dinocephalians and early anomodonts. The Middle Permian thus had a tetrapod fauna very distinct from that of the Early Permian. The Middle-Late Permian (Kazanian-Tatarian) boundary is easily identified by numerous tetrapod extinctions (16 families) and originations (29 families).

Late Permian tetrapods

Only a few new families of amphibians and diapsid reptiles appeared during the Late Permian (Tatarian) (Figs. 2-3). The distinctiveness of the Late Permian tetrapod fauna is due to its domination by dicynodont herbivores and therapsid carnivores, especially the gorgonopsids and therocephalians. Many of these taxa continued at the family level into the Triassic. Late Permian tetrapods define the dicynodontid empire of Anderson and Cruickshank (1978), which was widespread across Late Permian Pangea. Particularly significant was the widespread dicynodontid genus Dicynodon (-Daptocephalus); its fossils are known across much of Late Permian Pangea – from South and East Africa, England, Russia and China. Some caveats and conclusions The type of database shown in Figures 2-4 and the support it provides for recognizing a threefold Permian is not above criticism. Some caveats include:

1. Correlating many nonmarine tetrapod fossil occurrences to the standard global chronostratigraphic scale is fraught with problems and uncertainty.
2. The Kungurian-Ufimian gap in the tetrapod fossil record makes it less certain whether a real evolutionary turnover occurred at the end of the Artinskian or was ”smeared” over Artinskian-Ufimian time.
3. The global compilations of tetrapod family diversity used here incorporate a welter of problems due to taxonomy, paraphyly and intensity of study. It would be better to analyze Permian tetrapod diversity at the genus and species level, though this would not eliminate all these problems.
4. Such compilations also suffer from the compiled correlation effect (Lucas, 1994). To wit, they only plot taxon ranges at

PER	EPOCH	AGE	CHARACTERISTIC TETRAPODS
PERMIAN	LATE	Tatarian	Dicynodontids and carnivorous therapsids
	MIDDLE	Kazanian	Dinocephalians and early anomodonts
		Ufimian	
		Kungurian	
	EARLY	Artinskian	Pelycosaurs, primitive temnospondyls, microsaurs, anthracosaurs and cotylosaurs
		Sakmarian	
		Asselian	

Figure 1. Tetrapod vertebrates (amphibians and reptiles) delineate a threefold Permian.

the level of stage-age, which artificially concentrates originations and extinctions at the stage boundaries.

These caveats underscore just how coarse-scaled an analysis I have undertaken. Nevertheless, I doubt that a finer-scaled analysis would alter the identification of three phases of Permian tetrapod evolution. Romer (1966) identified these phases long ago, and they provide a strong basis for recomizing three Permian epochs. What vertebrate paleontologists have known for 30 years is at last being recognized by students of marine Permian biochronology.

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Spencer G. Lucas
New Mexico Museum of Natural History,
1801 Mountain Road N.W.
Albuquerque, New Mexico 87104 USA

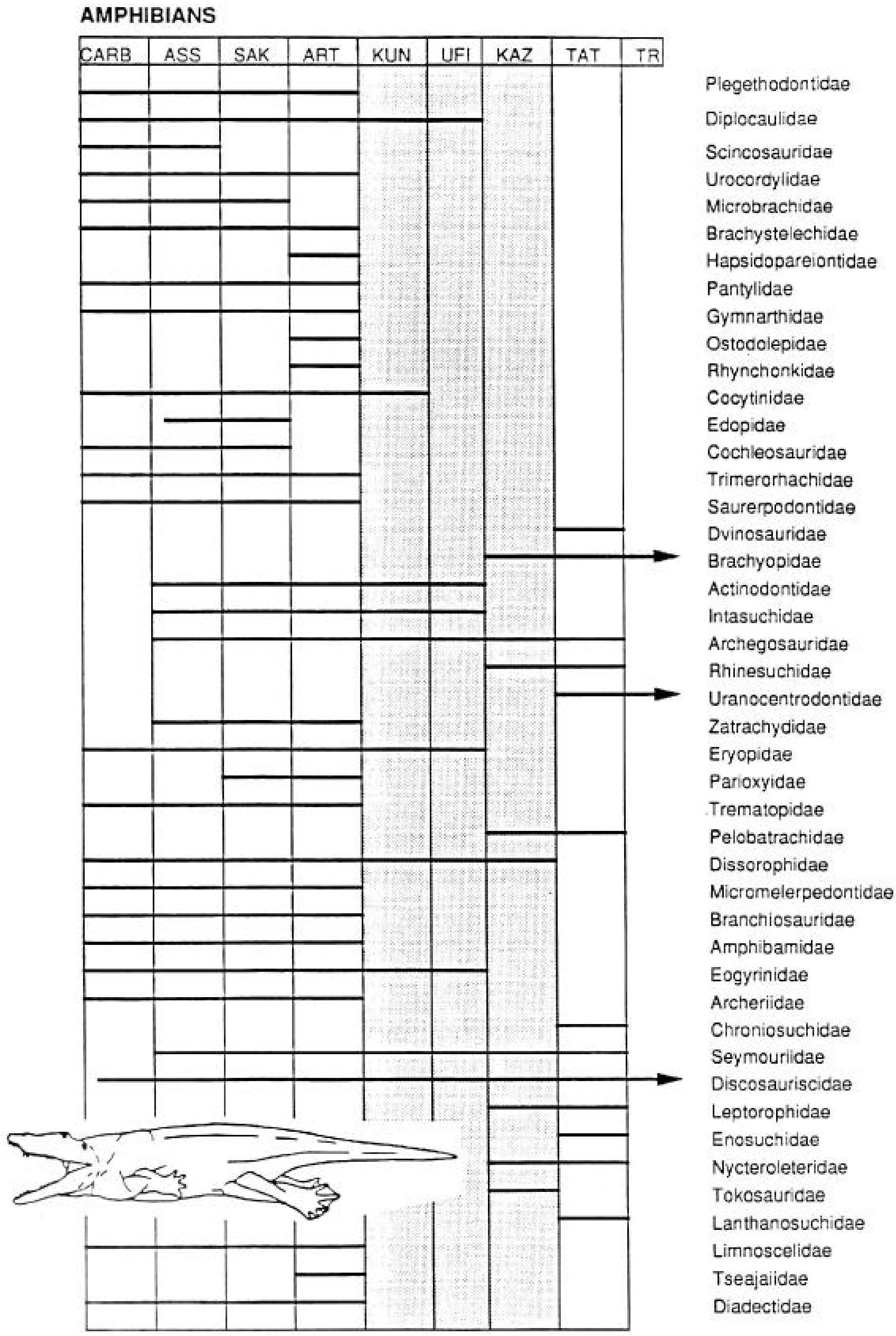

Figure 2. Temporal distribution of amphibian families during the Permian based on Milner (1993b). Timescale abbreviations at top denote (from left to right): Carboniferous, Asselian, Sakmarian, Artinskian, Kungurian, Ufimian, Kazanian and Tatarian.

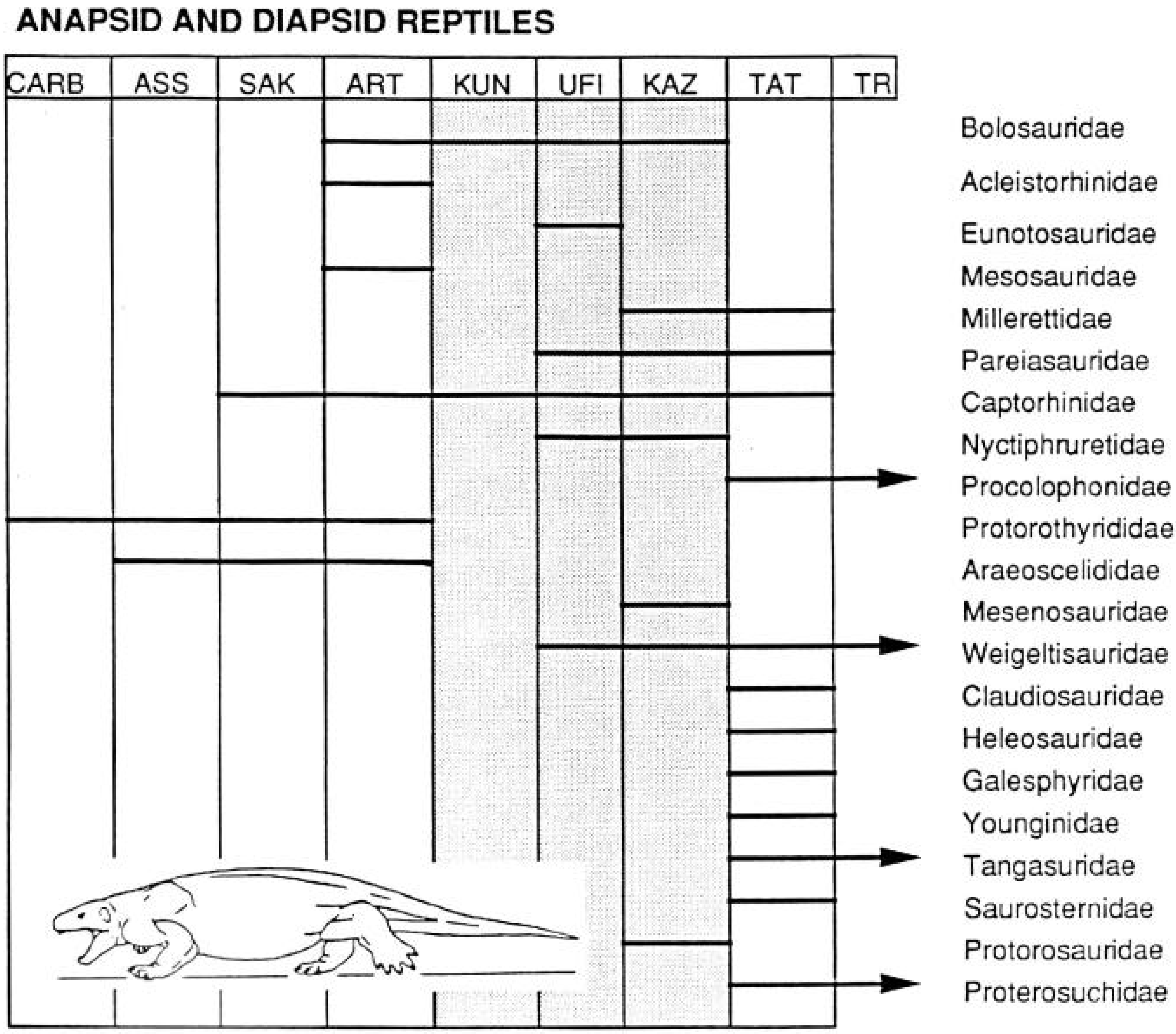

Figure 3. Temporal distribution of anapsid and diapsid reptile families during the Permian based on Benton (1993). Timescale abbreviations as in Figure 2.

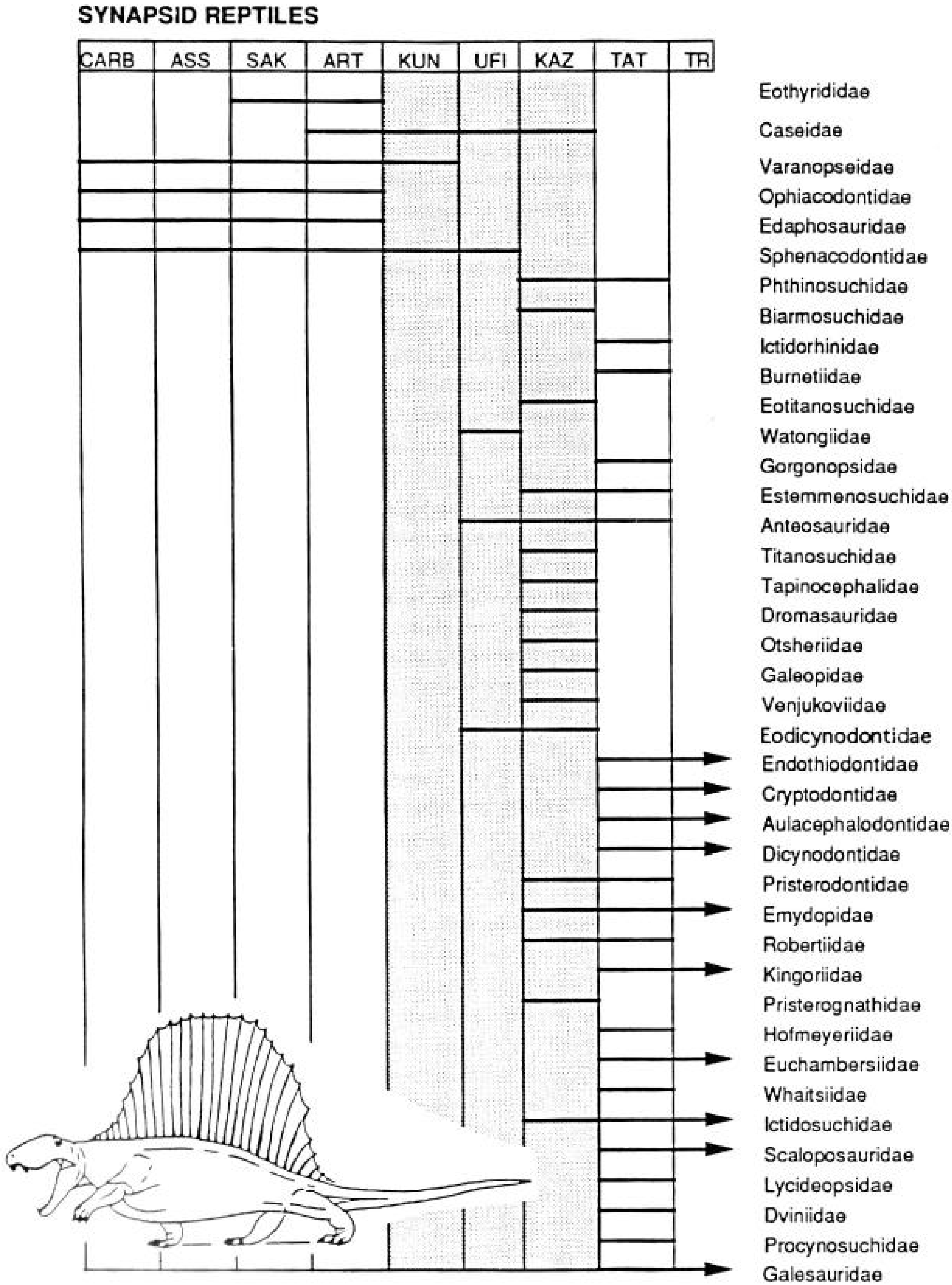

Figure 4. Temporal distribution of synapsid reptile families during the Permian based on Benton (1993). Timescale abbreviations as in Figure 2.

23. REVISED PERMIAN LITHOSTRATIGRAPHY IN THE NETHERLANDS

Recently, a completely revised lithostratigaphic nomenclature of the Netherlands has been published (Van Adrichem Boogaert and Kouwe, 1993-1995), which replaces the NAM and RGD (1980) edition. Since 1980, a considerable drilling effort has been carried out in the Netherlands onshore and offshore areas. The additional well information led to new insights in the lithostratigraphy of the Permian deposits. The most important changes will be described below.

Permian deposits are now recognized in a much larger area than previously. In much of the basin fringe area in the southern Netherlands strata which previously were assigned to the Carboniferous have been identified as Upper Permian deposits. This has been proved by palynological analysis in the uppermost claystones, The strata consist of sandstones and conglomerates of the Upper Rotliegend Group and claystones of the uppermost part of the Zechstein Group (Van Adrichem Boogaert and Kouwe, 1993-1995; Geluk et al., 1995). This new interpretation indicates, that here no important overstepping of the permian basin margins occurred during the Triassic, as was assumed previously, but that the basin margin stayed more or less in the same position.

In two distinct areas in the Netherlands, namely the eastern onshore area and the area of the Central North Sea Graben, volcanoclastic deposits of the Lower Rotliegend Group have been identified. No detailed age dating have been performed, but in analogue to Germany, the deposits are regarded as Early Permian (Asselian?). The occurrence of these deposits indicate an early phase of activity of the Central North Sea Graben.

The Upper Rotliegend Group is identified in almost the entire country; it is, after the work of Menning (1995), now considered to be of Late Permian age. Several new members were introduced for an adequate description of the situation where the sandy Slochteren Formation interfingers with the argillaceous Siverpit Formation.

In the Zechstein Group, the redefinition of the boundary with the overlying Buntsandstein enables a better separation between the lithostratigraphic Permian and Triassic. In the past, this boundary had not been described clearly and transitional beds had been grouped together in the Basal Buntsandstein Member, now the lower part of these beds have been defined as the Upper Zechstein Claystone Formation and the overlying part is considered to belong to the Triassic. Palynological associations in these beds are dominated by the presence of *Lueckisporites virkkiae*. The boundary almost matches the lithostratigraphical boundary as defined in Germany and Poland. Furthermore, the clastic deposits representing the basin fringe facies has been incorporated in the lithostratigraphic scheme.

Attempts were undertaken for a definition of the chronostratigraphical boundary between the Permian and Triassic on the basis of palynomorphs in the Everdingen-1 well in the central Netherlands. The Permian-Triassic boundary is believed to be situated within the Lower Buntsandstein. Despite several grey intervals in the Lower Buntsandstein, the strata were found barren.

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M.C. Geluk
P.O. Box 157
2000 AD Haarlem
The Netherlands

24. RESEARCH IN PROGRESS ON THE PERMIAN DEPOSITS OF SARDINIA ITALY)

Two years ago, a team of Italian geologists renewed research on the Permian sedimentary and volcanic deposits of Sardinia. The need of such research arose from the scarcity of detailed information on this subject, and from the pressing imminence of the new Sheet 541 “Jerzu”, 1:50,000, of the Geological Map of Italy. Subsequently, French (J. Broutin, F. Lethiers, P. Freytet) and Italian (P. Pittau, A. Tintori) specialists were invited to take part in this research.

The Perdasdefogu and Escalaplano intramontane basins, in southeastern Sardinia, were the subject of the most thorough investigation. Detailed research by Ronchi on these basins led to new paleontological findings, to the reconstruction of the stratigraphic successions of the basins, to new insights into the particular nature of some carbonate and siliceous deposits, and to a definition of volcanic activity in the area during Permian.

OGLIASTRA: *Perdasdefogu* basin

A representative stratigraphic section of this basin, which is located near the village of Perdasdefogu, is given in Figure 1. The succession begins with a reddish conglomerate (max. 30 m thick) that bears rock fragments derived from the Hercynian metamorphic basement. The boundary with this complex is marked by a pronounced unconformity. Above, grey-dark laminated sandstones, siltstones and shales crop out, in association with more or less consistent calcalkaline andesitic products.

From the numerous specimens collected by Ronchi in this lower unit, Broutin points out the presence of the following plants: *Asterophyllites longifollus* (Sternberg) Brongniart, *Annularia mucronata* Schenk, *Pecopteris elaverica* Zeiller, *Odontopteris lingulata* (Goeppert) Schimper, *1Veuropteris osmundae* (Artis) Kidston (*Odontopteris dupesnoyi*), *Taeniopteris abnormis* Gutbier, *Autunia* (al. *Callipreris) conferta* (Brongniart) Haubold et Kerp, *Rhachiphyllum* (al. *Callipteris) schenkii* (Heyer) Kerp, *Rhachiphyllum* (al. *Callipteris) lyratifolia* (Goeppert) Kerp, *Dichophyllum* (al. *Callipteris) flabellifera* (Weiss) Kerp et Haubold, *Lodevia* (al. *Callipreris) nicklesii* (Zeiller) Haubold et Kerp, *Ernestiodendronfiliciforme* (Sternberg) Florin, *Otovicia* (al. *Walchia) hypnoides* (Florin) Kerp et al., *Walchia piniformis* Sternberg (sensu Visscher et al., 1986), *Culmitzchia* (al. *Lebachia) laxifolia* (Florin) Clement-Westerhof, etc. According to Broutin, these forms enable us to relate these strata to Autunian of the French and Pyrenean Catalan basins. At the top of the same unit, Ronchi also discovered a large number of amphibians of very small dimensions (on average 5-6 cm). Tintori considers these vertebrates as belonging to the Branchiosauridae fam., of which no sighting has so far been made in Italian areas. Ostracods, which are referred by Lethiers to *Candona* n. sp., cf. *planidorsata* Cooper, 1946 and *Whipplella* aff. *carbonaria* Scott, 1944, also occur in the whole unit.

The fossiliferous levels are followed upwards by stratified limestones, which are locally involved in silification phenomena, and are intercalated with black bedded cherts of volcanic origin.

Above, the aforementioned sediments come into contact with a widespread dacitic lava flow, calcalkaline in nature, of which the thickness reaches up to a maximum of 180 m. However, in the northwestern sector of the basin, these dacitic rocks are associated with, or are followed by, rhyolitic volcaniclastic sediments, mostly in the form of tuffs and ignimbrites, which are again of calcalkaline composition. Sparse dacitic and rhyolitic dikes linked to this younger volcanic activity also appear in the basin area, where they cross the Hercynian crystalline complex and the overlying units already described.

The total thickness of the sedimentary and volcanic succession of the Perdasdefogu basin, which can be generally ascribed to Lower Permian, shows an average value of 250 m. Upwards of these deposits, very coarse grained Mid-Jurassic conglomeratic massive beds crop out.

GERREI: *Escalaplano* basin

About 10 km south of Perdasdefogu, the Permian Escalaplano basin is also located near the village. A representative stratigraphic section is shown in Figure l. The base of the succession is again characterised by the presence of conglomerates (max 15 m thick), which contain rock fragments pertaining to the Hercynian crystalline substrate. Contact with this complex is underlined by a marked unconformity. The overlying deposits consist of repeated alternation of sandstones, siltstones, shales, silicified limestones, bedded cherts, all intercalated with abundant volcaniclastic products, which have been interpreted as rhyolitic tuffs and ignimbrites, and, further up, as andesitic lahars, all three being of calcalkaline composition. These rocks are followed by a thick andesitic body, whose products are correlatable with those of the lower part of the Perdasdefogu basin.

Scarce reddish clastic sediments, which are interbedded at the top with chalky and marly-clayey sediments, unconformably overlie the Hercynian metamorphic basement at the margin of the basin . These clastic deposits could pertain to a transitional Buntsandstein, prior to marine Middle Triassic carbonate transgression. The deposits yield a microfloristic assemblage, with *Alisporites microreticulatus* Reinhardt, *Angustisulcites klausii* Freudenthal, *Cuneatisporites radialis* Leschik, *Falcisporites snopkovae* Visscher, *Minutosaccus crenulatus* Dolby, *Rimaesporires potoniei* Leschik, *Stellapollenites muelleri* (Reinsch and Schmitz) Pittau Demelia, *Triadispora stabilis* Scheuring, *T. obscura* Scheuring, *T. suspecta* Scheuring, *T. vilis* Scheuring, *Vitreisporites signatus* Leschik, as well as other forms, which are generally ascribed by Pittau (pers. comm.) to a Middle Anisian (Pelsonian) age. However, in the Escalaplano basin, the above-cited andesites and the presumed former late-Paleozoic cover were widely sutured by the already mentioned Middle Jurassic conglomerates, and, even more evidently, by Eocene deposits.

Although the Escalaplano basin succession has not yet provided paleontological data, regional comparison leads researchers to consider the present deposits as Lower Permian (Autunian).

GERREI: *Mulargia* basin.

This basin is situated a little to the west of the Escalaplano ba-

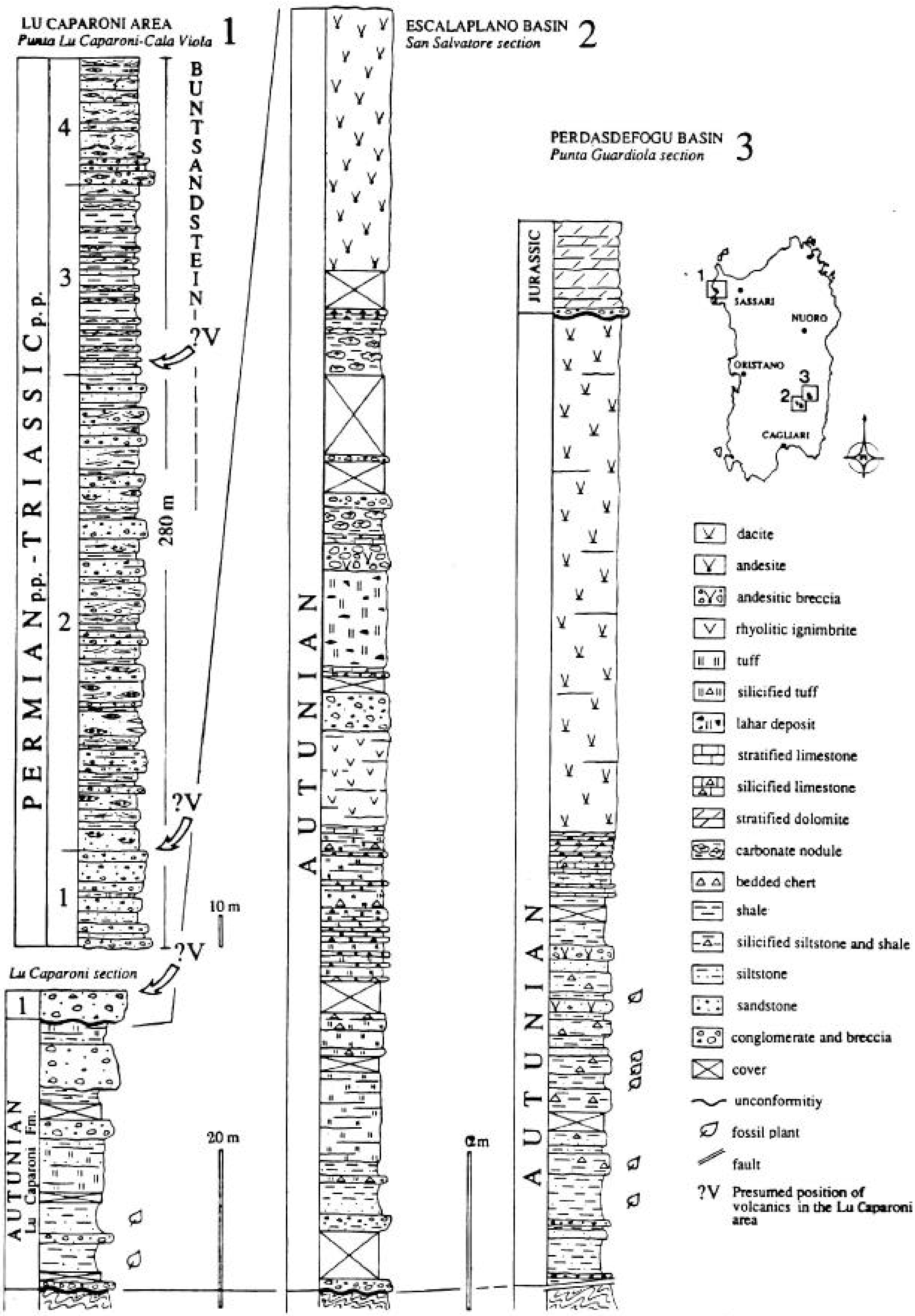

Figure 1. Location and stratigraphic columns of the investigated areas. 1: Lu Caparoni basin and surroungings; 2: Escalaplano (E) and Mulargia (W) basins; 3: Perdasdefogu basin.

sin, around Lake Mulargia. The siltstones and shales of the lower stratigraphic succession near Rio Melas gave a number of vegetal fossils, among which Broutin recognized: *Pecopteris* cf. *densifolia* (Goeppert) Weiss, *Ernestiodendron filiciforme* (Sternberg) *Florin*, *Otovicia* (al. *Walchia) hypnoides* (Florin) Kerp et al., Walchia piniformis Sternberg (sensu Visscher et al., 1986), Hermitia (al. *Walchia)* spp., Culmitzchia (al. *Lebachia) laxifolia* (Florin) Clement-Westerhof. According to Broutin, these forms indicate the presence of Autunian, a hypothesis which has already been advanced (Francavilla et al., 1977).

NURRA: *Lu Caparoni* basin and surroundings

Located in northwestern Sardinia, near Alghero, this area has recently been subjected to new stratigraphic and petrographic research (Cassinis et al., in press). The post-Hercynian continental succession can be subdivided into at least two main tectonosedimentary cycles. The lower cycle is characterised by the Lu Caparoni Formation, which reaches up to about 15 m in thickness. According to the stratigraphic section of Figure 1, this formation begins with a thin and discontinuous conglomeratic deposit, 1-1.5 m thick, which bears metamorphic fragments derived from the Hercynian substrate. The boundary is marked by a distinct unconformity and by a palaeosol. Upwards, this basal conglomerate is followed by alluvial-lacustrine, black, laminated, sandstones, siltstones and shales, all rich in fossil plants.

From a number of specimens collected by Ronchi at two levels, Broutin recognised: *Autunia* (al. *Callipteris) conferra* (Brongniart) Haubold et Kerp, *Odontopteris* cf. *subcrenulata* Rost, *Walchia piniformis* Sternberg (sensu Wisscher et al., 1986), *Otovicia* (al. *Walchia) hypnoides* (Florin) Kerp et al., *Ernestiodendron filiciforme* (S ternberg) Florin, Dichophyllum (al. *Callipteris) flabelIifera* (Weiss) Kerp et Haubold, *Pecopteris* sp., *Rachiphyllum* (al. *Callipteris) lyratifolia* (Goeppert) Kerp, *Taeniopteris* sp., *Remia pinnatifida* (Gutbier) Knight, *Pecoperis polymorpha* Brongniart. Like the previous authors (Pecorini, 1972; Francavilla in Gasperi and Gelmini, 1980), Broutin points out that these forms indicate the Autunian, and he thus reproposes a Lower Permian age for the aforementioned deposits.

The onset of subsequent volcaniclastic activity is documented by the presence of some kaolinized cinerites. In all probability, the overlying massive polygenic conglomerates and sandstones represent a consequence of this new explosive activity. However, between these clastics, we again observe two flat and eroded lenses of fine-grained stratified bodies, which resemble the Lu Caparoni Formation units. These sediments are accompanied by kaolinized and illitized volcaniclastic products, similar to the underlying ones, and also include traces of presumed palaeosols.

As is evident a little below the Lu Caparoni peak, the starting of the upper tectonosedimentary cycle is marked by a slight unconformity. The detrital succession of this cycle, the thickness of which may be estimated at around 250-300 m, has been subdivided into four Units (Gaspari and Gelmini, 1980).

These Units are characterized, from bottom to top, by (Fig. 1): I) quartz whitish massive conglomerates, with variable amounts of sandy matrix, and white sandstones, with horizontal bedding and bioturbation. This unit essentially consists of metamorphic and volcanic quartz; the latter is connected with a more or less coeval volcanic activity, and is mixed with kaolinized products (30-40 m thick); 2) alternation of reddish conglomerates and sandstones, both characterized by tabular and trough cross-stratification, channel fills, and intercalated with vivid red siltstone lenses. The conglomerates range in thickness from 2 to 15 m, and are composed of quartz, red volcanic and basement fragments (about 150 m thick); 3) grey-greenish sandstones, from centimetrical to metrical in thickness, alternated with intense red siltstones. The sandstones show tabular and trough cross-stratification, mud cracks, as well as ripple marks (about 50 m thick); 4) reddish fine and medium-grained sandstones, in decimetrical beds, with tabular and trough cross-stratification and, at the top, ripple marks and bioturbation. A very coarse white quartz conglomerate, 3-6 m thick, with red matrix, crops out at the lowermost part of the unit (50-60 m thick).

With the exception of number 1, the units show a notable lithological affinity with the Buntsandstein of France and Spain; this is particularly so for Units 3 and 4.

Moreover, the temporal distribution of all this detrital succession clearly ranges from Autunian to Ladinian times. However, if we consider firstly the paucity and the inconclusiveness of the paleontological findings relative to these clastics (Pecorini, 1962; Pittau Demelia and Flaviani, 1982), and secondly the data reported by studies on the subsequent Triassic transgression in this part of Sardinia (Pomesano Cherchi, 1968; Pittau Demelia and Flaviani, 1982; Gandin et al., 1982), it also seems plausible to suggest that the continental succession examined generally began during undefined Permian times and ended during the Anisian.

The volcanic products locally intercalated within the middle-lower part of the aforementioned succession (their presumed position is indicated beside the column) appear to be excessively weathered to yield reliable data. About 15 km to the north of the Lu Caparoni area, only a handful of samples picked near M. Santa Giusta can be interpreted as tuffs and ignimbrites of alkaline affinity (see also Lombardi et al., 1974). In Nurra, therefore, the hypothesis of a second similar magmatic cycle, which has been widely recognized and studied outside the isle, i.e., inside the post-Autunian and pre-Triassic sections of Corsica and South-France, is probably appropriate. These volcanic data lend weight to the assumption that the Sardinia block was connected to stable Europe during the Permian.

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Broutin, J., Cassinis, G.
Cortesogno, L., Gaggero, L.
Ronchi, A., Sarria, E.

(B.J.: UPMC, Lab. Palaobotanique et Palaoacologie, 12 Rue Cuvier, 75005 Paris, France; C.G.: Dip. Scienze della Terra, Via Abbiategrasso 217, 27100 Pavia, Italy; C.L.: Dip. Scienze della Terra, Corso Europa 26, 16132 Genova, Italy; G.L.: Dip. Scienze della Terra, Corso Europa 26, 16132 Genova, Italy; R.A.: Dip. Scienze della Terra, Via Abbiategrasso 217, 27100 Pavia, Italy; S.E.: PROGEMISA, Via Contivecchi 7, 09122 Cagliari, Italy).

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