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FORAMINIFERAL TIMING OF CARBONATE DEPOSITION ON THE LATE DEVONIAN (FAMENNIAN)-MIDDLE PENNSYLVANIAN (BASHKIRIAN) TENGIZ PLATFORM, KAZAKHSTAN

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Abstract. Calcareous foraminifers provide a time-stratigraphic framework to chronicle the development of the Tengiz carbonate platform that thrived from the latest Devonian (late Famennian) into the Middle Pennsylvanian (late Bashkirian). Correlative zones, based on documented foraminiferal assemblages and expressed primarily in terms of Russian horizons, confirm that the platform grew in a complex pattern of progradation and backstepping from the Tournaisian to late Visean and then underwent a major progradation that was terminated by sea level fall at the end of the Serpukhovian.

Favorable conditions for carbonate sedimentation returned in the early Bashkirian and persisted into the late Bashkirian until the platform either was exposed and eroded or buried by siliciclastic deposition. Breaks in the foraminiferal succession point to major depositional hiatuses along the top of the Bashkirian platform, at the Mississippian-Pennsylvanian boundary, and possibly in the late Tournaisian although previous investigations support continuous deposition throughout the latter interval at Tengiz.

Riassunto. I foraminiferi calcarei forniscono uno strumento cronologico per tarare lo sviluppo della piattaforma carbonatica di Tengiz, che si è sviluppata dal Devoniano sommitale (Famenniano superiore) al Carbonifero superiore (Bashkiriano superiore). Le zone utilizzate per la correlazione, che sono basate su associazioni documentate di foraminiferi, e che sono essenzialmente espresse in termini di Orizzonti Russi, confermano che la piattaforma crebbe in un contesto complesso di progradazioni e ritiri dal Tournesiano al tardo Viseano. Successivamente si verificò una progradazione maggiore che terminò con la caduta del livello del mare alla fine del Serpukhoviano.

Le condizioni favorevoli per la sedimentazione carbonatica ritornarono nel Bashkiriano inferiore e persistettero nel Bashiriano superiore sino a che la piattaforma fu o esposta ed erosa oppure seppellita dalla sedimentazione silicoclastica. Lacune nella successione a foraminiferi indicano la presenza di importanti hiatus deposizionali alla sommità della piattaforma bashkiriana, in corrispondenza del limite Mississippiano-Pennsylvaniano (Carbonifero inferiore/superiore) e possibilmente nel tardo Tournesiano, sebbene ricerche precedenti ritengano che a Tengiz la sedimentazione fu continua attraverso questo ultimo intervallo di tempo.

Introduction

Tengiz, the super giant oil field located along the northeastern shore of the Caspian Sea (Fig. 1), is one of a number of isolated carbonate platforms that developed in the southern Pricaspian Basin from the Late Devonian into the Middle Pennsylvanian (Krylov et al. 1994, figs. 1, 2; Cook et al. 1994, fig. 7). Since the field's discovery in 1979, Soviet and, later, Kazakh and Western workers have undertaken stratigraphic studies on the genesis of the platform carbonates and surrounding siliciclastic beds (e. g., Krylov et al. 1994; Wood & Garber 1996; Harris et al. 1999). Most published biostratigraphic studies utilized calcareous foraminifers for age dating the platform (Aleshin et al. 1988, 1989; Zolotukhina & Taboyakova 1988; Zolotukhina et al. 1988, 1989; Krivonos 1991; Vlasova et al. 1991; Zolotukhina & Danshina 1992; Gibshman 1997) because of the proven application of this fossil group to shallow-water carbonate environments.

Tengizchevroil, the current operator of the field, recently assembled a team of geologists, sequence stratigraphers, geophysicists and foraminiferal biostratigraphers to model the sedimentological and structural development of the Tengiz platform (Clark et al. 2000; Harris & Warner 2000; Harris 2001; Harris et al. 2000, 2001; Kenter & Harris 2002). The current paper reports more results of that ongoing study with emphasis on the general geological development of the buildup and on the foraminiferal assemblages used to establish time lines across the platform and slope regions. The intent is to provide an overview of the stratigraphic setting and biota through time. Detailed well-to-well correlations and discussion of internal sedimentary geometries are beyond the scope of this report. Data for biostratigraphic interpretations and illustrated microfossils come from cored intervals within the wells shown on Fig. 2 and Tab. 1.

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Fig. 1 - Location of Tengiz and major cities in the Caspian Sea region.

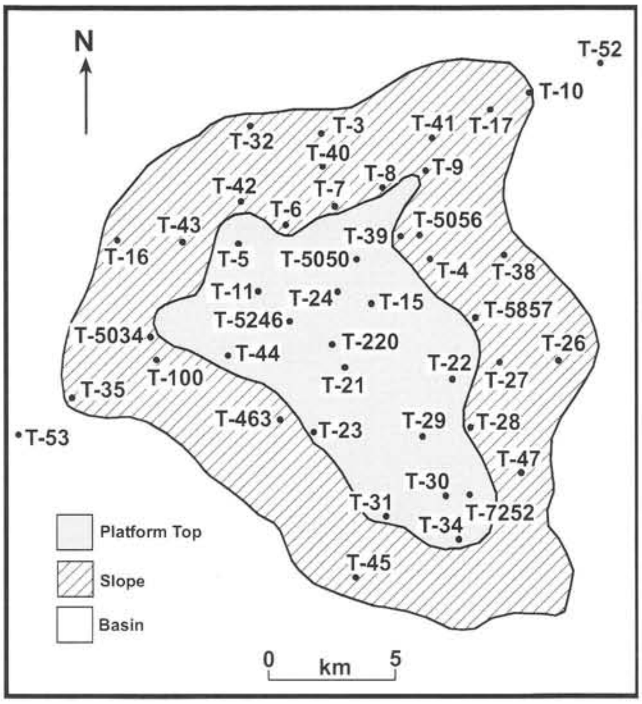

Fig. 2 - Areal map of the Tengiz Platform, showing locations of wells used for this study and generalized position of the platform top, slope and basin from the late Visean into the Middle Pennsylvanian. Older core intervals in proximal slope wells were situated on the top of the platform.

Geologic setting

The physiography of the Tengiz Platform is analogous to modern carbonate platforms such as those that surround the Caicos Islands and the Bahamas (Rubins et al. 1996). These buildups rise precipitously from the ocean floor and exhibit a variety of shallow-water carbonate facies across the top and slopes. The areal configuration of the Tengiz Platform is given in Fig. 2 and a schematic northeast-southwest cross section divided into major time segments is included in Fig. 3. Fig. 4 correlates these time slices to both larger and smaller time-stratigraphic units. The development of Tengiz followed the opening of the Pricaspian Basin by rifting of the Ustyurt plate form the East European plate in the Middle Devonian (Heubeck 2001).

Platform growth began in the Famennian with the accumulation of skeletal packstones, grainstones and wackestones possibly on top of a Frasnian carbonate shelf. Initially sedimentation followed a complex pattern of progradation and backstepping at different positions along the platform edge. Wells located in the platform center have a relatively continuous sequence from the latest Visean downward (Tab. 1). Those drilled on the edge show diverse stratigraphic relationships, including late Visean beds directly overlying the Tournaisian or late Famennian (T-17 and T-47 wells), or early Serpukhovian-latestVisean horizons on early Visean beds of the Radaevsky Horizon (T-43 and T-463 wells). The platform top may have been exposed near the Tournaisian-Visean boundary because typical late Tournaisian (Kosvinsky Horizon) microfossils do not seem to be present there.

During late Visean and Serpukhovian time the buildup began to prograde extensively and developed into distinct platform and slope settings (Fig. 2, 3). The platform beds are mostly skeletal grainstones and packstones. Many of these contain abundant foraminifers and are interpreted to be shallow-water, open marine deposits. Others contain few foraminifers but are rich in red algae that presumably thrived in a deeper-water setting.

The upper to middle slope is composed of autochthonous microbial boundstone that more or less surrounded the platform and dropped steeply away from the platform edge. The lower slope is composed primarily of brecciated boundstone debris flows that extended in some cases onto the basin floor. The microbiota is similar across the slope region.

Sedimentation changed dramatically in the early Bashkirian following a global sea level fall at the Mississippian-Pennsylvanian boundary. Although skeletal, grain-supported rocks are common, ooid shoals, rarely seen in older beds, covered the platform and prograded over the Serpukhovian slope. Carbonate deposition that ended in the late Bashkirian was either localized on the platform

AGE	Dev.	Tournaisian					Visean				Serp.		Bashkirian				
↓ WELL \ H-S →	Fa	G-M	Up	Ch	Ki	Ko	Ra	Bo	Tu	A-V	T-S	Pr	B?-S	LS	Ak	As	LB
T-3															x		
T-4											x	x					
T-5										x			x	x	x		
T-6								x	x	x		x					
T-7									?	x	x	x	?	x	x	x	
T-8										x	?	x	x	?	x	x	
T-10	?									x	x						
T-11											x		x				
T-15											x		?				
T-16											x				x	x	
T-17	x									x	?	x					
T-21											x			x			
T-22	x	x	x	x	x	?	x	x	x	x	?		x	x			
T-23													x				
T-24								x	x	x	?	x	?				
T-26											x						
T-27															?		x
T-28										x	?				x		
T-29										x	x		x				
T-30								x	x	x	?				x		
T-31									?	x	?				x		
T-32								?	?						x		
T-34										x		?	x	x	x		
T-35									x	x	x						
T-38												x			x		
T-39									?	x	?				x		
T-40												x			x	?	
T-41	x				x		x				x						
T-42											?	x					
T-43					?		x			x							
T-44								x	?	x	?	x		x	x		
T-45												x			x		
T-47	x	?							x	?	x						
T-52	x					x		x		x		x					
T-53					x	x			x	x	x						
T-100												x					
T-220									x	x	x	x	?	x	x	x	x
T-463	x				?		x				x						
T-5034										x	?						
T-5050	x								x	x	x	x	x				
T-5056	?			x	x		x				x						
T-5857	x																
T-7252				x													

Table 1 - Core coverage for wells shown in Fig. 2. H-S=horizon or stage; Fa=late Famennian Stage; G-M=Gumerovsky and Malevsky horizons (undifferentiated); U=Upinsky Horizon; Ch=Cherepetsky Horizon; Ki=Kizelovsky Horizon; Ko=Kosvinsky Horizon; Ra=Radaevsky Horizon; Bo=Bobrikovsky Horizon; Tu=Tulsky Horizon; A-V=Aleksinsky, Mikhailovsky and Venevsky horizons (undifferentiated); T-S=Tarussky and Steshevsky horizons (undifferentiated); Pr=Protvinsky Horizon; B?-S=Bogdanovsky?-early Syuransky horizons; LS=late Syuransky Horizon; Ak=Akavassky Horizon; As=Askynbashsky Horizon; LB=late Bashkirian horizons.

at that time, or the surface was exposed and differentially eroded. Whatever the scenario, the final platform topography was irregular and in places no younger than early Bashkirian (Akavassky-Askynbashsky horizons). Basinal shales and siltstones that were deposited contemporaneously with the carbonates during platform growth eventually blanketed the platform in the Middle/Late Pennsylvanian and Early Permian. Restricted conditions developed by mid-Permian time when Kungurian evaporites precipitated across the basin.

Chronostratigraphy/Biostratigraphy

Smaller time-stratigraphic units in the Former Soviet Union are traditionally called horizons and that terminology, where applicable, is used in this report (Fig. 4). Horizon names for Mississippian rocks (Tournaisian, Visean and Serpukhovian) come from the Russian Platform and those for the Early to Middle Pennsylvanian (Bashkirian) are derived from the type Bashkirian sections in the southern Urals. The relationship of horizons

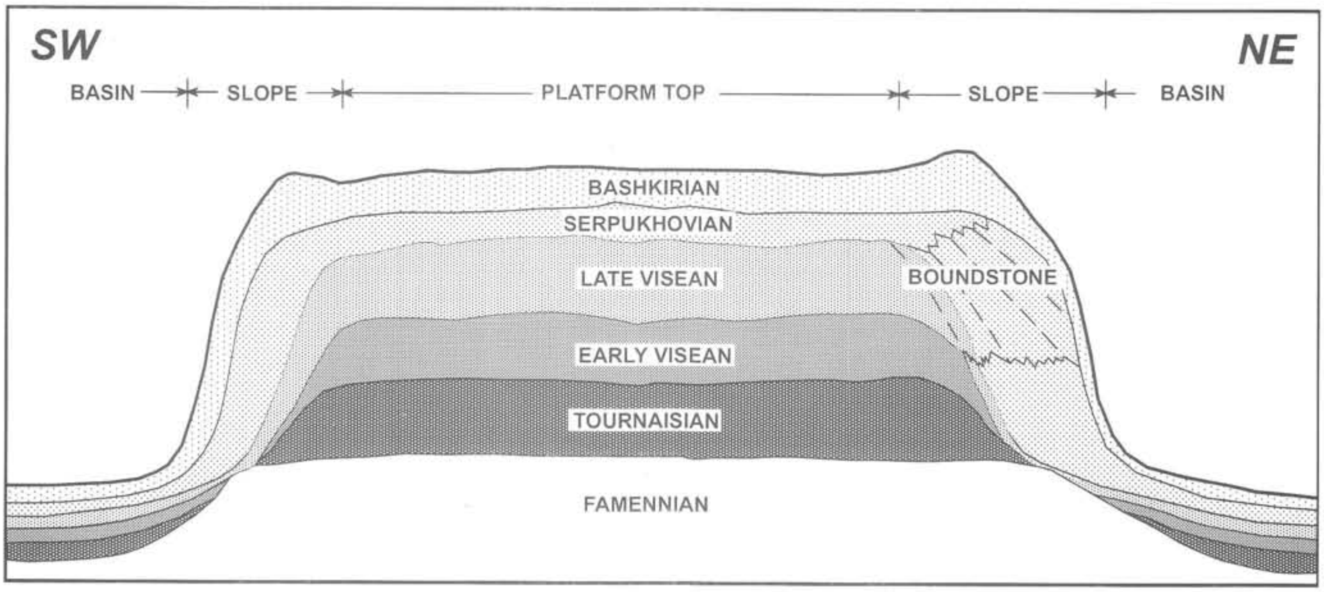

Fig. 3 - Schematic cross section through the Tengiz Platform from northeast to southwest; no scale. Platform top, slope and basin correspond to those shown in Figure 2.

to foraminiferal zones and assemblages on the Russian Platform are outlined, for example, in Kagarmanov & Donakova (1990), Vdovenko et al. (1990), Makhlina et al. (1993) and Shcherbakov (1997), and for the type Bashkirian, in Sinitsyna & Sinitsyn (1987), Groves (1988), Kulagina & Sinitsyna (1997), Groves et al. (1999) and Kulagina et al. (2001).

Calcareous foraminifers complemented by algae and incertae sedis were used herein to date the Tengiz platform, slope, and contemporaneous basinal beds which contain platform-derived turbidites interlayered with the siliciclastics. The stratigraphic distribution of microfossils from the platform and slope areas (Fig. 2, 3) is given in Tab. 2 and those taxa critical for identifying a specific horizon or stage from those areas are mentioned in the following discussion (Representative specimens are illustrated on Pls. 1-7).

Late Famennian: the stratigraphically oldest platform/slope cores that can be dated unequivocally contain diagnostic late Famennian *Eoendothyra* and *Quasiendothyra* species along with *Rectoseptaglomospiranella asiatica* and *Menselina* sp. In addition to the assemblage listed in Tab. 2, basinal beds in the T-52 well yielded *Rectoseptaglomospiranella elegantula* (Reitlinger) and *Septaglomospiranella nana*? Reitlinger. Long-ranging, simple unilocular and bilocular taxa (e. g., *Bisphaera*, calcisphaerids, *Cribrosphaeroides* , *Diplosphaerina* , *Eovolutina*, *Parathurammina*, radiosphaerids, *Vicinisphaera*) are the dominant microfossils throughout these Late Devonian beds.

Gumerovsky-Cherepetsky horizons (early Tournaisian): this interval is sparsely represented in the Tengiz cores and has a poorly developed biota. Gumerovsky/Malevsky beds contain unilocular and bilocular assemblages similar to those found in the late Fammenian. These lie above the Mississippian-Devonian boundary that is recognized operationally by the disappearance of the *Quasiendothyra-Eoendothyra* assemblage. *Eochernyshinella* sp. first occurs in the Upinsky Horizon and the appearances of *Chernyshinella* species and *Palaeospiroplectammina tchernyshinensis* characterize the Cherepetsky Horizon.

Kizelovsky Horizon (late Tournaisian): important occurrences within this horizon include those of *Endospiroplectammina venusta*, *Eoforschia* cf. *moelleri*, *Neobrunsiina latispiralis*, *Spinoendothyra* species and *Urbanella urbana*.

Radaevsky Horizon (early Visean): foraminiferal workers generally used the first occurrence of the genus *Eoparastaffella* to recognize the base of the Visean, following the definition proposed for type sections in the Dinant Basin of Belgium (Conil et al. 1976, 1989). This definition is now considered inadequate because the first occurrences in the Dinant Basin are cryptogenic and represented by *E. simplex*, a species that is younger than the oldest representatives of the genus (Hance, Brenckle et al. 1997). A proposal is now before the Carboniferous Subcommission (Sevastopulo & Hance 2000) to place the Tournaisian-Visean boundary within a continuous *Eoparastaffella* succession at about the appearance of *E. simplex* (Hance 1997; Hance, Muchez et al., 1997). Under this definition species of *Eoparastaffella* occurring below *E. simplex* would belong to the latest Tournaisian. Gibshman (1997) recognized an interval of pre-*simplex* species in Tengiz and proposed a new Tournaisian *Eoparastaffellina rotunda* Zone to accomodate that assemblage (Gibshman & Kulagina 2001). Although these proposals have great merit, the appearance of the genus *Eoparastaffella*, the species notwithstanding, is used in this report to recognize the earliest Visean because of the difficulty of identifying *Eoparastaffella* species in unoriented sections from the

RUSSIAN SERIES	RUSSIAN STAGES		RUSSIAN HORIZONS	SYSTEM/SUBSYSTEM	TENGIZ PLATFORM
MIDDLE CARBONIFEROUS (PART)	LATE	BASHKIRIAN	Asatausky Tashastinsky	PENNSYLVANIAN (PART)	
	EARLY		Askynbashsky Akavassky Syuransky Bogdanovsky		
LOWER CARBONIFEROUS	LATE	SERPUKHOVIAN	Zapaltyubinsky Protvinsky	MISSISSIPPIAN	
	EARLY		Steshevsky Tarussky		
	LATE	VISEAN	Venevsky Mikhailovsky Aleksinsky Tulsky		
	EARLY		Bobrikovsky Radaevsky		
	LATE	TOURNAISIAN	Kosvinsky Kizelovsky		
	EARLY		Cherepetsky Upinsky Malevsky Gumerovsky		
UPPER DEVONIAN	FAMENNIAN			DEVONIAN (PART)	
	FRASNIAN				

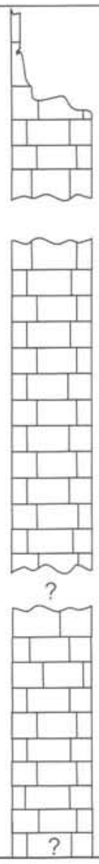

Fig. 4 - Stratigraphic terminology used in this paper. Column at far right shows a generalized Tengiz rock sequence and locations of major stratigraphic breaks along the top of the platform.

sparsely fossiliferous and/or mostly discontinuous core around the Tournaisian-Visean boundary at Tengiz. Future critical study may necessitate reassignment of some well intervals to the Tournaisian.

Other important taxa appearing in the Radaevsky include *Eoendothyranopsis donica*, *Koninckopora* sp., *Latiendothyranopsis paraconvexa*, "*Loeblichia*" *fragilis* and *Pseudolituotuba gravata*.

Bobrikovsky Horizon (early Visean): the first occurrence of the Archaediscidae (*Glomodiscus*, *Uralodiscus*, *Viseidiscus*) distinguishes this level that otherwise has a biota similar to the Radaevsky Horizon. *Paraarchaediscus* specimens occur higher in the interval.

Tulsky Horizon (late Visean): this level is recognized on the appearances of *Archaediscus* of the group *A. moelleri*, *Endostaffella* species, *Endothyranopsis compressa*, *Globoendothyra globula*, palaeotextulariids (*Consobrinella*, *Cribrostomum*, *Koskinotextularia*, *Palaeotextularia*), *Pojarkovella nibelis*, *Pseudoendothyra* species and *Vissariotaxis exilis* accompanied by an influx of *Paraarchaediscus* species. Occurrences of *Biseriella*, *Eoparastaffella* and *Glomodiscus* are apparently limited to the lower part of the horizon.

Aleksinsky-Venevsky horizons (late Visean): the latest Visean on the Russian Platform is divided into the Aleksinsky, Mikhailovsky and Venevsky horizons (Fig. 4) that collectively were assigned to the Oksky Superhorizon in older Soviet stratigraphic schemes (e. g., Belskaya et al. 1975). Taxa characteristic of these horizons occur abundantly in some Tengiz wells, but they do not appear consistently across the platform or always in the proper stratigraphic order. Hence the horizons cannot be identified confidently and they are not differentiated in this paper. Facies may partly be responsible for the inconsistent foraminiferal distribution at Tengiz. Calcareous foraminifers preferred shallow-water environments but many Aleksinsky-Venevsky beds are encrinites containing mostly stacheiin, aoujgalin or ungdarellin red algae that may have lived in slightly deeper water than generally tolerated by multilocular foraminifers. In addition, the ages of microfossil occurrences may differ between the Russian Platform and Tengiz because of migration patterns or because multiple exposure events and unfavorable facies on the shallow Russian Platform (e. g., see Belskaya et al. 1975, p. 19-22, 90-93, 150-151; Makhlina et al. 1993, fig. 3) possibly truncated foraminiferal ranges.

Characteristic forms appearing in this interval are *Archaediscus* aff. *approximatus*, *A.* cf. *enormis*, *A.* aff. *gigas*, *Asteroarchaediscus* cf. *baschkiricus*, *A. rugosus*, *Bradyina rotula*, *Calcifolium okense*, *Chantonia* sp., *Climacammina* of the group *C. antiqua*, *Cribrospira mira*, *Dainella*? *tujmasensis*, *Endothyranopsis crassa*, *E. sphaerica*, *Eostaffella constricta*, *E.* of the group *E. ikensis*, *E. mosquensis*, *E. parastruvei*, *E. proikensis*, *Fasciella kizilia* , *Haplophragmella fallax*, *H. tetraloculi*, *Haplophragmina beschevensis* "*angularis*", *Howchinia bradyana*, *Janischewskina typica*, *Mirifica mirifica*, *Neoarchaediscus agapovensis*, *N. akchimensis* , *N. tumefactus*, *Omphalotis omphalota*, *O. pannusaeformis*, *Paraarchaediscus maximus*, *Permodiscus vetustus*, *Plectogyranopsis regularis* , *Rectocornuspira buskensis*, *Spinothyra pauciseptata*, indeterminate stacheiin alga (new genus?), and *Ungdarella* sp.

Tarussky-Protvinsky horizons (Serpukhovian): during the late Visean, Tengiz sedimentation began to differentiate into distinctive platform and slope settings that became fully developed in the Serpukhovian (Fig. 3). Platform beds at this time were detrital, skeletal grain-dominated and the slope was composed primarily of sparry-peloidal, clotted, microbial boundstone and boundstone breccias (Clark et al. 2000; Kenter & Harris 2002) . Detrital-skeletal sediments, nevertheless, are common in slope beds adjacent to the platform (Fig. 2) and as matrix in the lower slope breccias. These beds contain abundant microfossil assemblages that resemble those found in the platform region.

In contrast, microfossils are relatively rare, poorly preserved and undiversified in the boundstone where encrusting foraminifers and algae predominate. Major elements of the microfauna include species of *Turrispiroides* [*T. multivolutus*, *T. subcarbonicus*, unidentified species] and lasiodiscids [*Eolasiodiscus donbassicus*, *Monotaxinoides* cf. *declivis*, *M.* cf. *subplanus*, *M. transitorius*] that suggest the late Serpukhovian in Russian zonal schemes (e. g., Einor 1973; Aizenverg et al. 1983; Vdovenko et al. 1990; Nikolaevna et al. 2001). Direct correlation of boundstone and platform beds, however, is tenuous for lack of interfingering detrital-skeletal rocks in slope cores from some wells (T-16, T-26, T-41, T-47), and lasiodiscid occurrences cannot be precisely calibrated to the platform. Furthermore, these foraminifers favored the microbial environment and may have appeared earlier in the boundstone than elsewhere. For these reasons the age of the boundstones is not differentiated although slope taxa from the detrital-skeletal lithologies permit recognition of early and late Serpukhovian beds in other wells. Additional Serpukhovian markers in the boundstone include *Biseriella* of the group *B. parva*, *Frustulata asiatica*, *Globivalvulina* of the group *G. bulloides*, *Palaeonubecularia* spp. and *Praedonezella cespeformis*.

The Tarussky-Steshevsky (early Serpukhovian) microbiota in the detrital-skeletal lithologies is essentially a continuation of that found in the Aleksinsky-Venevsky interval (Vdovenko et al. 1990). Because traditional early Serpukhovian markers such as *Biseriella parva*, spherical pseudoendothyrids and *Eostaffellina decurta* are rare at Tengiz, the position of the Visean-Serpukhovian and Tarussky-Steshevsky boundaries is difficult to locate consistently in the well cores, although taxa such as *Eostaffella gruenewaltdi*, *Frustulata asiatica*, *Globotetrataxis elegantula*, *Monotaxinoides* cf. *transitorius*, *Planoendothyra* sp., and *Praedonezella cespeformis* are useful in recognizing the Serpukhovian. Reexamination of Serpukhovian foraminiferal occurrences on the Russian Platform (Gibshman 2001a, b) and in the Urals (Nikolaeva et al. 2001) is in progress and these studies may lead to improvements in characterizing this stratigraphic interval.

The Protvinsky Horizon (late Serpukhovian) in the detrital-skeletal beds is recognized primarily on the appearance of *Bradyina concinna*?, *B. cribrostomata*, *Eostaffella* aff. *irenae*, *Eostaffellina* species and *Globivalvulina* of the group *G. bulloides* within assemblages that contain many holdovers from the early Serpukhovian. Other possibly diagnostic indicators include *Eolasiodiscus donbassicus*, *Globotetrataxis grandis*, *Monotaxinoides priscus*, *Planoendothyra* cf. *aljutovica*, *P. spirilliniformis*, *Plectostaffella jakhensis*, *Quasilituotuba* cf. *subplana* "*segmentata*", *Rectoendothyra latiformis*, *Semiendothyra* sp., *Turrispiroides multivolutus* and *T. subcarbonicus*.

Bogdanovsky?-early Syuransky horizons (earliest Bashkirian): sea level drop at the Mississippian-Pennsylvanian boundary eliminated most boundstone production, and deposition across the platform became dominantly oolitic (Harris et al. 2000) when marine conditions returned during the early Bashkirian. Recovery of the microbiota was slow, and definable assemblages cannot be recognized with confidence until the appearance of the primitive fusulinids *Semistaffella variabilis* and *Pseudostaffella* spp. in the late Syuransky and Akavassky horizons. The earliest Bashkirian biotas contain sparse taxa that originated mostly in the Serpukhovian and can be distinguished more by their lack of characteristic Mississippian forms than by a distinctive association. Further complicating correlation is the fact that in a few wells (T-220, T-5050, T-5056) the lower ooid beds and interfingered detrital-skeletal sediments contain *Koninckopora* spp., *Janischewskina* sp. and possibly *Calcifolium okense* that are considered to be typically Mississippian. These taxa are not obviously reworked although that interpretation is a possibility. Their presence could also indicate a wedge of Serpukhovian ooid deposits or microfossil range extensions into the Bashkirian.

Definitive taxa appearing in the earliest Bashkirian include *Eostaffella chomatifera*, *E. postmosquensis acutiformis*, *E. pseudostruvei*, *Globivalvulina* of the group *G. granulosa*?, *Millerella marblensis*, *Plectostaffella* of the group *P. varvariensis*, *Pseudoendothyra circuli*, and possibly *Semistaffella* sp.

Late Syuransky Horizon (early Bashkirian): this unit, approximately equivalent to the newly established Kamennogorsky Horizon of the South Urals (Kulagina et al. 2001), includes the stratigraphic interval from the appearance of *Semistaffella variabilis* (Reitlinger) to that of *Pseudostaffella*. Other occurrences that may be useful to recognize this interval include those of *Archaediscus* cf. *pseudomoelleri*, *Climacammina fragilis*, *Eostaffella* aff. *dolixa*?, and *Palaeotextularia vulgaris*.

Akavassky Horizon (Early Bashkirian): this horizon is marked by the appearance and radiation of *Pseudostaffella* specimens, many of which belong to *P. antiqua antiqua* (Dutkevitch) and related forms. *Ozawainella aurora* is another characteristic species appearing in the Akavassky but only a few, questionable specimens were identified.

Post-Akavassky horizons (Bashkirian): our microfossil studies of post-Akavassky horizons are incomplete but cursory examination shows that in some areas carbonate sedimentation continued into the late Bashkirian before platform growth ended. The Askynbashsky Horizon (early Bashkirian) is represented by a microbiota that includes, *Eoschubertella* sp., ?*E. mosquensis*, *Profusulinella* of the group *P. parva*, *Pseudostaffella praegorskyi* and *Staffellaeformes* of the group *S. staffellaeformis* as well as many taxa found in the Akavassky.

The late Bashkirian is recognized in very few wells and no attempt was made to distinguish individual horizons. Microfossils diagnostic of this interval include *Aljutovella*? sp., *Ozawainella* cf. *alchevskiensis*, *O.* of the group *O. fragilis*, *O.* cf. *pararhomboidalis*, *O.* aff. *pogorevichi*, *Profusulinella* of the group *P. pararhomboides* and *Timanella* sp.

Unconformities

Because foraminiferal distribution is highly facies-dependent, recognition of individual horizons across the Tengiz Platform is not always clear-cut especially in restricted environments or areas of relatively deeper-water sedimentation where diagnostic taxa tend to be less abundant or absent. Lack of key forms could be attributed to facies control but equally so to sedimentary breaks that would be expected in a shallow platform environment. Numerous gaps probably remain undetected because they are below the resolution of the microfossil succession, but there are at least three levels on the top of the platform that may have significant stratigraphic hiatuses (Fig. 4).

Kosvinsky Horizon (late Tournaisian): a typical Kosvinsky microfossil assemblage from the Middle Urals contains the first occurrences of *Darjella monilis* Malakhova, *Eotextularia diversa* (Chernysheva), *Tetrataxis* and other taxa as well as numerous forms that originate in the underlying Kizelovsky Horizon (Brenckle 1997). The apparent absence of this association across the top of the Tengiz platform suggests a possible break in the late Tournaisian, although other investigators (Kagarmanov & Donakova 1990; Krylov et al. 1994; Gibshman 1997; Gibshman & Kulagina 2001) interpret deposition to be continuous throughout the Tournaisian at Tengiz or in the Pricaspian Basin in general. Russian foraminiferal zonations (e. g., Kagarmanov & Donakova 1990) assign the Kosvinsky Horizon to the *Dainella staffelloides-Eoforschia moelleri* Zone, elements of which occur in Tengiz. These occurrences by themselves, however, cannot be used to identify the Kosvinsky because both zonal name-bearers and related forms exist in the Kizelovsky (Vdovenko et al. 1990; Brenckle 1997).

The T-52 and T- 53 wells (Fig. 2) yielded Tournaisian assemblages with *Darjella monilis*, *Eotextularia diversa*, and *Tetrataxis* sp. among other taxa, including *Brunsia* cf. *irrregularis* (Möller), *Dainella chomatica* (Dain), *Endospiroplectammina venusta* (Vdovenko), *Eotournayella* sp., *Inflatoendothyra parainflata* (Bogush & Yuferev), *Issinella devonica* (Reitlinger), *I. grandis* (Chuvashov), *Kamaena delicata* Antropov, lituotubellid, *Latiendothyranopsis* cf. *grandis* (Lipina), *Laxoendothyra* sp., ?*Mediendothyra obscura* (Brazhnikova & Vdovenko) , *Palaeospiroplectammina* sp., "*Priscella*" sp., *Septaglomospiranella* sp., *Spinochernella brencklei*? Conil & Lys, *Spinoendothyra* sp., *S.* cf. *paracostifera* (Lipina) and *Urbanella urbana* (Malakhova). Because these are basinal wells, the foraminifers might be part of debris flows shed from Kosvinsky sediments deposited on the platform flanks during a late Tournaisian lowstand or remnants of Kosvinsky deposits from the top of the platform that were eroded and transported during the same lowstand. If the latter interpretation is the case, other remnants of Kosvinsky rocks should be expected on the platform proper, but as yet no unequivocal assemblages have been found there.

Mississippian-Pennsylvanian boundary: there is a break at the Serpukhovian-Bashkirian boundary that coincides with a worldwide regression at the end of the Mississippian Subsystem. Physical evidence of the regression includes numerous exposure surfaces within Tengiz cores that were drilled across the Mississippian-Pennsylvanian boundary. Paleontologic evidence includes the virtual absence of eosigmoilinid foraminifers [*Eosigmoilina robertsoni* (Brady), *Brenckleina rugosa* (Brazhnikova)] that are zonal indices for the late Serpukhovian Zapaltyubinsky and equivalent horizons (e. g., Kagarmanov & Donakova 1990; Kulagina & Sinitsyna 1997). These foraminifers are ubiquitous in Late Mississippian limestone shelf deposits of the Northern Hemisphere and should also be expected on the shallow Tengiz Platform. They do occur in argillaceous limestones in the nearby Saztobe field southeast of Tengiz (Gibshman 1993) where deposition was presumably on a deeper shelf that remained below sea level during the lowstand. The absence of eosigmoilinids at Tengiz accounts for the difficulty in distinguishing earliest Bashkirian (Bogdanovsky?-early Syuransky) from Serpukhovian deposits because many earliest Bashkirian foraminifers originated in the Serpukhovian and cannot be easily dated without the intervening eosigmoilinids.

Earliest Bashkirian marine deposits apparently overlie the Serpukhovian in most wells but in a few wells late Syuransky or Akavassky beds seem to be in contact with the Serpukhovian. Platform drowning at the beginning of the Bashkirian, therefore, may have been controlled not only by worldwide sea-level rise but also by local topographic relief formed during the regression or by structural movements on the platform.

Late Bashkirian: The last major hiatus is associated with the carbonate surface at the top of the platform. This surface ranges in age from Akavassky or Askynbashsky to late Bashkirian but the mechanism controlling its formation is uncertain. One possibility is that the platform was exposed and differentially eroded to create a topography of variable age that was later covered by siliciclastics. An alternative explanation is that rising sea level began to drown the platform at the end of the early Bashkirian but local areas of carbonate deposition kept pace until buried by siliciclastics in the late Bashkirian.

Acknowledgements. We thank the members of the Tengiz modeling team, who provided the geologic framework and supported the development and publication of this study. They include Michael Clark, Ben Robertson, Aigul Tyshkanbaeva and Dennis Fischer of Tengizchevroil; Mitch Harris of ChevronTexaco; Jim Weber and Steven Bachtel of ExxonMobil; Jeroen Kenter of Vrije University and Alexei Pronin of Kazakhstancaspishelf. Adriaan van Ginkel helped identify late Baskirian foraminifers and Thomas Dignes of ChevronTexaco helped us acquire pertinent literature. Anna Vaynberg of ChevronTexaco drafted the text-figures and printed the photomicrographs. Reviewers Nilyufer Gibshman of the Gubkin Academy and Ji i Kalvoda of Masaryk University provided constructive suggestions for improving the content of the paper and the presentation of the data. We also thank Tengizchevroil for financial support of this project and, along with its partner companies, for permission to publish the paper.

PLATE 1

Specimens housed in Building 5, Tengizchevroil Village, Atyrau Oblast, Kazakhstan, except those designated KCS that are reposited at the Kazakhstancaspishelf Company in the city of Atyrau. Magnifications x 75 except as indicated. Well locations shown in Fig. 2.

Fig. 1 - *Rectoseptaglomospiranella asiatica* (Reitlinger). Late Famennian, T-47 well, 5670.53 m, x 50.
Fig. 2 - *Eoendothyra baidjansaica* (Bogush & Yuferev). Late Famennian, T-52 well, 6074.05 m.
Fig. 3 - *Eoendothyra turbida* (Durkina). Late Famennian, T-52 well, 6074.05 m.
Fig. 4 - *Eoendothyra communis* (Rauzer-Chernousova). Late Famennian, T-5857 well, 5196.84 m, KCS.
Fig. 5 - *Quasiendothyra* sp. Late Famennian, T-5857 well, 5204.29 m, KCS.
Fig. 6 - *Palaeospiroplectammina tchernyshinensis* (Lipina). Cherepetsky Horizon, T-7252 well, 5417.89 m, x 50, KCS.
Fig. 7 - *Chernyshinella* sp. Cherepetsky Horizon, T-7252 well, 5410.30 m, KCS.
Fig. 8 - *Septaglomospiranella kingirica*? Reitlinger. Late Famennian, T-5050 well, 5194.00 m.
Fig. 9 - *Septaglomospiranella primaeva "kazakhstanica"* Reitlinger. Late Famennian, T-5050 well, 5194.00 m.
Fig. 10 - *Septaglomospiranella* sp. Kizelovsky Horizon, T-5056 well, 4822.13 m.
Fig. 11 - *Septaglomospiranella compressa* Lipina. Kizelovsky Horizon, T-53 well, 6442.30 m.
Fig. 12 - *Menselina* sp. Late Famennian, T-41 well, 4995-5000 m.
Fig. 13, 14- *Palaeospiroplectammina* cf. *parva* (Chernysheva). Kizelovsky Horizon, T-41 well, 4894-4901 m.
Fig. 15 - *Palaeospiroplectammina guttula* (Malakhova). Kizelovsky Horizon, T-43 well, 4827-4840 m.
Fig. 16 - *Tournayella* cf. *discoidea* Dain. Kizelovsky Horizon, T-5056 well, 4872.16 m.
Fig. 17 - *Endospiroplectammina venusta* (Vdovenko). Kizelovsky Horizon, T-5056 well, 4852.46 m.
Fig. 18 - *Laxoendothyra* aff. *parakosvensis* (Lipina). Cherepetsky Horizon, T-7252 well, 5417.89 m, KCS.
Fig. 19 - *Laxoendothyra parakosvensis* (Lipina). Kizelovsky Horizon, T-41 well, 4788-4793 m.
Fig. 20 - *Granuliferella latispiralis* (Lipina). Kizelovsky Horizon, T-5056 well, 4868.06 m.
Fig. 21 - *Granuliferella rjausakensis* (Chernysheva). Radaevsky Horizon, T-43 well, 4635.20 m.
Fig. 22, 23 - *Inflatoendothyra parainflata* (Bogush & Yuferev). Fig. 22 - Bobrikovsky Horizon, T-44 well, 4663-4666 m; Fig. 23 - Kosvinsky Horizon, T-52 well, 5859.46 m.
Fig. 24 - *Urbanella* cf. *urbana* (Malakhova). Kizelovsky Horizon, T-5056 well, 4888.6 m.
Fig. 25 - *Neobrunsiina latispiralis* (Lipina). Kizelovsky Horizon, T-41 well, 4788-4793 m.
Fig. 26, 27 - *Eoforschia* cf. *moelleri* (Malakhova). Kizelovsky Horizon, T-5056 well. Fig. 26- 4869.07 m; Fig. 27 - 4880.07 m.
Fig. 28 - *Spinoendothyra* cf. *paracostifera* (Lipina). Kizelovsky Horizon, T-43 well, 4827-4840 m.
Fig. 29 - *Spinoendothyra media* (Vdovenko). Kizelovsky Horizon, T-5056 well, 4822.13 m.
Fig. 30 - *"Spinoendothyra" paraukrainica* (Lipina). Kizelovsky Horizon, T-5056 well, 4872.16 m.
Fig. 31 - *Spinoendothyra tenuiseptata* (Lipina). Kizelovsky Horizon, T-41 well, 4783-4788 m.
Fig. 32 - *Glomospiranella* sp. Kizelovsky Horizon, T-5056 well, 4822.13 m.
Fig. 33 - *Dainella chomatica* (Dain). Kosvinsky Horizon, T-52 well, 5858.79 m.
Fig. 34 - *Darjella monilis* Malakhova. Kosvinsky Horizon, T-52 well, 5859.46 m, x 40.


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PLATE 2

Specimens housed in Building 5, Tengizchevroil Village, Atyrau Oblast, Kazakhstan. Magnifications x 75 except as indicated. Well locations shown in Fig. 2.

Fig. 1, 2 - *Eotextularia diversa* (Chernysheva). Kosvinsky Horizon. Fig. 1 - T-52 well, 5857.68 m; Fig. 2 - T-53 well, 6364.40 m.

Fig. 3 - *Latiendothyranopsis grandis* (Lipina). Bobrikovsky Horizon, T-44 well, 4663-4666 m.

Fig. 4 - *Pseudolituotubella tenuissima* (Vdovenko). Radaevsky Horizon, T-43 well, 4784-4797 m, x 50.

Fig. 5 - *"Loeblichia" fragilis* (Lipina). Bobrikovsky Horizon, T-44 well, 4663-4666 m, x 100.

Fig. 6 - *Eogloboendothyra* sp. Radaevsky Horizon, T-43 well, 4631-4643 m.

Fig. 7 - *Latiendothyranopsis paraconvexa* (Brazhnikova & Rostovtseva). Bobrikovsky Horizon, T-24 well, 4701.09-4701.13 m.

Fig. 8 - *Endospiroplectammina conili conili* Lipina. Radaevsky Horizon, T-5056 well, 4795.37 m.

Fig. 9 - *Viseidiscus monstratus* (Grozdilova & Lebedeva). Bobrikovsky Horizon, T-44 well, 4663-4666 m, x 150.

Fig. 10 - *Pseudolituotubella* cf. *septaglomospiroides* (Vdovenko). Radaevsky Horizon, T-463 well, 4814.70 m.

Fig. 11 - *Dainella chomatica* (Dain). Radaevsky Horizon, T-43 well, 4797-4811 m.

Fig. 12 - *Eoparastaffella* sp. Radaevsky Horizon, T-41 well, 4738-4743 m.

Fig. 13 - *Eoparastaffella simplex* Vdovenko. Bobrikovsky Horizon, T-44 well, 4663-4666 m.

Fig. 14 - *Eoparastaffella simplex "lata"* Vdovenko. Bobrikovsky Horizon, T-44 well, 4684-4687 m.

Fig. 15 - *Glomodiscus biarmicus* Malakhova. Bobrikovsky Horizon, T-44 well, 4663-4666 m, x 150.

Fig. 16 - *Glomodiscus oblongus* (Conil & Lys). Bobrikovsky Horizon, T-44 well, 4663-4666 m, x 100.

Fig. 17, 18 - *Uralodiscus rotundus* (Chernysheva). Bobrikovsky Horizon, T-24 well, x100. Fig. 17 - 4703.10-4703.15 m; Fig. 18 - 4701.09-4701.13 m.

Fig. 19 - *Bessiella* sp. Bobrikovsky Horizon, T-44 well, 4663-4666 m.

Fig. 20 - *Brunsia irregularis* (von Möller). Bobrikovsky Horizon, T-44 well, 4663-4666 m.

Fig. 21 - *Septabrunsiina krainica* (Lipina). Radaevsky Horizon, T-43 well, 4784-4797 m.

Fig. 22, 23 - *Glomodiscus* sp. Early Tulsky Horizon, T-24 well, 4659-4661 m, and T-22 well, 4579.00 m, respectively, x 100.

Fig. 24 - *Paraarchaediscus* aff. *koktjubensis* (Rauzer-Chernousova). Tulsky Horizon, T-24 well, 4514. 18 m.

Fig. 25 - *Issinella devonica* Reitlinger; cylindrical thalli in various orientations. Bobrikovsky Horizon, T-24 well, 4703.55-4703.59 m, x 25.

Fig. 26, 27 - *Eoendothyranopsis donica* Brazhnikova and Rostovtseva. Bobrikovsky Horizon, T-44 well, 4663-4666 m, x 50 and x 75 respectively.

Fig. 28, 29 - *Paraarchaediscus* sp. Fig. 28 - Tulsky Horizon, T-24 well, 4514.18 m; Fig. 29 - Early Tulsky Horizon, T-22 well, 4638.5 m, x 100.

Fig. 30, 31 - *Paraarchaediscus dubitabilis* Orlova. Fig. 30 - Tulsky Horizon, T-24 well, 4469.45 m, x100; Fig. 31 - Early Tulsky Horizon, T-24 well, 4659-4661 m.

Fig. 32 - *Paraarchaediscus* aff. *pauxillus* (Shlykova). Early Tulsky Horizon, T-22 well, 4579.00 m, x100.


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PLATE 3

Specimens housed in Building 5, Tengizchevroil Village, Atyrau Oblast, Kazakhstan. Magnifications x 75 except as indicated. Well locations shown in Fig. 2.

Fig. 1, 2 - *Endothyranopsis compressa* (Rauzer-Chernousova & Reitlinger). Fig. 1 - Early Tulsky Horizon, T-22 well, 4638.50 m; Fig. 2 - Tulsky Horizon, T-24 well, 4514.92 m.

Fig. 3 - *Lituotubella glomospiroides* Rauzer-Chernousova. Tulsky Horizon, T-24 well, 4514.92 m.

Fig. 4 - *Omphalotis frequentata* (Ganelina). Early Tulsky Horizon, T-22 well, 4638.50 m.

Fig. 5 - *Koninckopora mortelmansi* Mamet. Tulsky Horizon, T-24 well, 4514.92 m, x 25.

Fig. 6 - *Pseudoendothyra struvii* (von Möller). Tulsky Horizon, T-24 well, 4469.45 m.

Fig. 7, 8 - *Pojarkovella nibelis* (Durkina). Fig. 7 - Tulsky Horizon, T-24 well, 4517.02 m; Fig. 8 – Aleksinsky-Venevsky horizons, T-53 well, 5704.89 m.

Fig. 9 - *Stacheoides meandriformis* Mamet & Rudloff. Tulsky Horizon, T-24 well, 4516.52 m.

Fig. 10 - *Valvulinella lata* Grozdilova & Lebedeva. Early Tulsky Horizon, T-24 well, 4659-4661 m.

Fig. 11 - *Vissariotaxis exilis* (Vissarionova). Tulsky Horizon, T-30 well, 4707.00 m, x 100.

Fig. 12 - *Biseriella bristolensis*? Early Tulsky Horizon, T-22 well, 4570-4581 m, x 100.

Fig. 13 - *Paraarchaediscus koktjubensis* (Rauzer-Chernousova). Aleksinsky-Venevsky horizons, T-28 well, 4428.10-4428.20 m.

Fig. 14 - *Pseudolituotuba gravata* (Conil & Lys). Early Tulsky Horizon, T-24 well, 4659-4661 m, x 50.

Fig. 15 - *Pojarkovella* cf. *pura* Simonova. Aleksinsky-Venevsky horizons, T-44 well, 4337-4344 m.

Fig. 16 - *Koninckopora minuta* Weyer. Aleksinsky-Venevsky horizons, T-220 well, 4422.22 m, x 50.

Fig. 17 - *Omphalotis* aff. *omphalota* (Rauzer-Chernousova & Reitlinger). Aleksinsky-Venevsky horizons, T-44 well, 4248-4255 m, x 40.

Fig. 18 - *Omphalotis circumplicata* (Howchin). Aleksinsky-Venevsky horizons, T-44 well, 4248-4255 m, x 40.

Fig. 19 - *Paraarchaediscus convexus* (Grozdilova & Lebedeva). Aleksinsky-Venevsky horizons, T-53 well, 5705.91 m.

Fig. 20 - *Omphalotis chariessa* (Conil & Lys). Aleksinsky-Venevsky horizons, T-28 well, 4436.11 m.

Fig. 21 - *Globoendothyra globula* (Eichwald). Aleksinsky-Venevsky horizons, T-53 well, 5679.46 m, x 30.

Fig. 22 - *Cribrostomum eximiforme* Lipina. Aleksinsky-Venevsky horizons, T-28 well, 4428.10-4428.20 m, x 40.

Fig. 23 - *Palaeotextularia longiseptata* Lipina. Aleksinsky-Venevsky horizons, T-44 well, 4330-4337 m.

Fig. 24 - *Neoarchaediscus agapovensis* Ivanova. Aleksinsky-Venevsky horizons, T-5034 well, 4146.26 m.

Fig. 25 - *Plectogyranopsis convexa* (Rauzer-Chernousova). Aleksinsky-Venevsky horizons, T-28 well, 4428.10-4428.20 m.

Fig. 26 - *Plectogyranopsis regularis* (Rauzer-Chernousova). Aleksinsky-Venevsky horizons, T-28 well, 4436.11 m.

Fig. 27 - *Archaediscus* aff. *approximatus* Ganelina. Aleksinsky-Venevsky horizons, T-53 well, 5723.46-5723.51 m.

Fig. 28 - *Archaediscus* aff. *gigas* Rauzer-Chernousova. Aleksinsky-Venevsky horizons, T-5034 well, 4148.34 m.

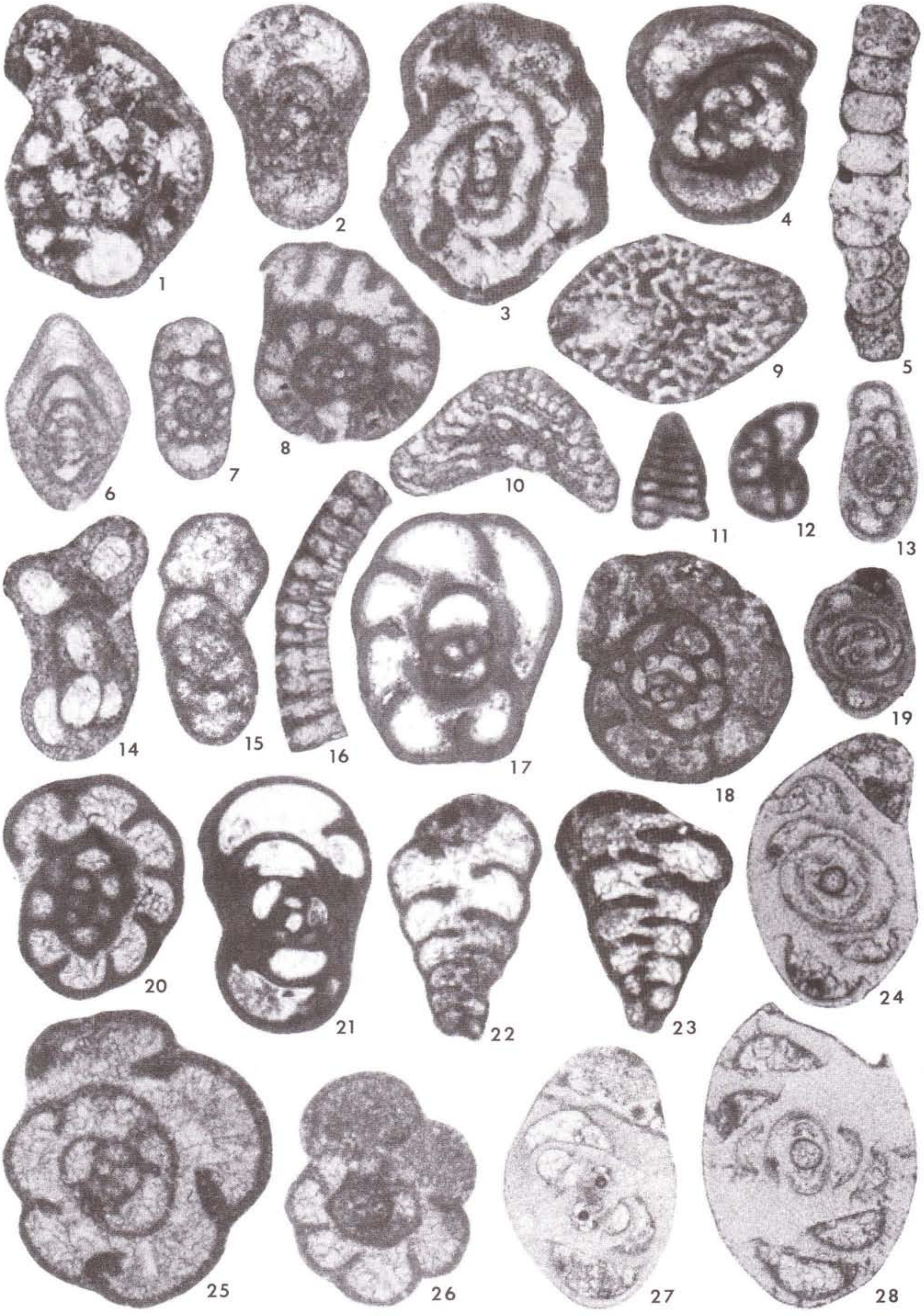
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PLATE 4

Specimens housed in Building 5, Tengizchevroil Village, Atyrau Oblast, Kazakhstan, except those designated KCS that are reposited at the Kazakhstancaspishelf Company in the city of Atyrau. Magnifications x 75 except as indicated. Well locations shown in Fig. 2.

Fig. 1	- *Endothyranopsis crassa* (Brady). Aleksinsky-Venevsky horizons, T-53 well, 5736.50 m.
Fig. 2, 3	- *Endothyranopsis sphaerica* (Rauzer-Chernousova & Reitlinger). Aleksinsky-Venevsky horizons. Fig. 2 - T-28 well, 4436.11 m, x 50; Fig. 3 – T-5034 well, 4146.26 m, x40.
Fig. 4	- *Forschia subangulata* (von Möller). Aleksinsky-Venevsky horizons, T-44 well, 4400-4404 m, x 50.
Fig. 5	- indeterminate organism. Aleksinsky-Venevsky horizons, T-44 well, 4400-4404 m.
Fig. 6, 7	- *Dainella? tujmasensis* (Vissarionova). Aleksinsky-Venevsky horizons. Fig. 6 – T-5246 well, 4433.02-4433.12 m, KCS; Fig. 7 – T-220 well, 4380.90 m.
Fig. 8	- *Bradyina rotula* (Eichwald). Aleksinsky-Venevsky horizons, T-5034 well, 4146.56 m, x 25.
Fig. 9	- *Endostaffella parva* (von Möller). Aleksinsky-Venevsky horizons, T-28 well, 4436.11 m.
Fig. 10	- *Janischewskina* sp. (thin-walled). Aleksinsky-Venevsky horizons, T-44 well, 4330-4337 m.
Fig. 11	- *Ortonella* sp. Aleksinsky-Venevsky horizons, T-28 well, 4428.10-4428.20 m, x 25.
Fig. 12	- *Endothyra phrissa* (Zeller). Protvinsky Horizon, T-17 well, 4890-4895 m.
Fig. 13	- *Calcifolium okense* Shvetzov & Birina. Early Serpukhovian, T-44 well, 4141-4148 m, x 50.
Fig. 14	- *Haplophragmella tetraloculi* Rauzer-Chernousova. Aleksinsky-Venevsky horizons, T-44 well, 4248-4255 m, x 25.
Fig. 15, 16, 17	- *Eostaffella* of the group *E. ikensis* Vissarionova. Fig. 15 - Serpukhovian, T-53 well, 5650.04-5650.16 m; Fig. 16 - Aleksinsky-Venevsky horizons, T-5034 well, 4148.34 m; Fig. 17 - Aleksinsky-Venevsky horizons, T-5034 well, 4149.00 m.
Fig. 18	- *Eostaffella parastruvei* (Rauzer-Chernousova). Aleksinsky-Venevsky horizons, T-53 well, 5705.91 m.
Fig. 19	- *Eostaffella infulaeformis* (Ganelina). Protvinsky Horizon, T-44 well, 4187-4192 m.
Fig. 20	- *Eostaffellina?* sp. Early Serpukhovian, T-5050 well, 4141. 19 m.
Fig. 21	- *Eostaffella mosquensis mosquensis* Vissarionova. Aleksinsky-Venevsky horizons, T-44 well, 4248-4255 m.
Fig. 22, 23, 24	- *Eostaffella proikensis* Rauzer-Chernousova. Protvinsky Horizon, T-44 well, 4155-4162 m.
Fig. 25, 26	- *Eostaffella prisca* (Rauzer-Chernousova). Fig. 25 – Serpukhovian, T-53 well, 5649-5663 m; Fig. 26- Protvinsky Horizon, T-44 well, 4187-4192 m.
Fig. 27	- *Eostaffella* of the group *E. postmosquensis?* Kireeva. Protvinsky Horizon, T-17 well, 4890-4895 m.
Fig. 28	- *Eostaffella ovoidea* (Rauzer-Chernousova). Aleksinsky-Venevsky horizons, T-53 well, 5675-5689 m.
Fig. 29	- *Eostaffella* cf. *angusta* Kireeva. Protvinsky Horizon, T-47 well, 4756.8 m.

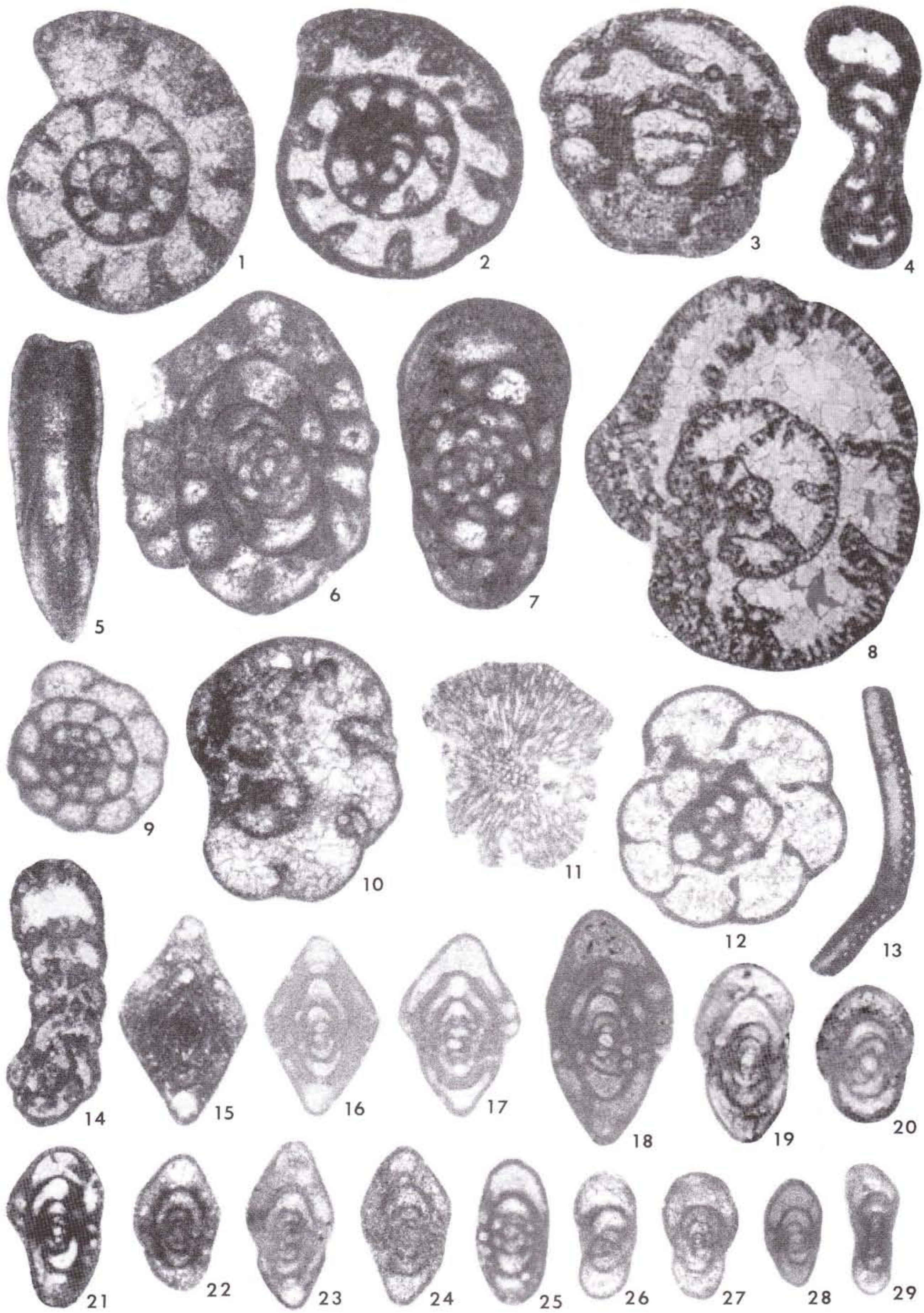
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PLATE 5

Specimens housed in Building 5, Tengizchevroil Village, Atyrau Oblast, Kazakhstan. Magnifications x 75 except as indicated. Well locations shown in Fig. 2.

Fig. 1 - *Mirifica uchtovensis* (Durkina). Early Serpukhovian, T-5050 well, 4139.60 m, x 50.

Fig. 2, 3 – *Bradyina* of the group *B. nautiliformis*? (von Möller). Protvinsky Horizon, T-44 well. Fig. 2 - 4155-4162 m, x 25; Fig. 3 – 4166-4171 m, x 30.

Fig. 4 - *Koskinotextularia cribriformis* Eickhoff. Protvinsky Horizon, T-44 well, 4192-4197 m.

Fig. 5 - *Janischewskina delicata* (Malakhova). Protvinsky Horizon, T-44 well, 4166-4171 m, x 50.

Fig. 6 - *Bradyina concinna*? Reitlinger. Protvinsky Horizon, T-44 well, 4166-4171 m, x 30.

Fig. 7 – indeterminate multiseptate foraminifer. Early Serpukhovian, T-5050 well, 4139.6 m, x 50.

Fig. 8 - *Chantonia* sp. Protvinsky Horizon, T-44 well, 4141-4148 m.

Fig. 9 - *Forschiella prisca* Mikhailov. Protvinsky Horizon, T-44 well, 4166-4171 m, x50.

Fig. 10, 11, 12 – *Eostaffella* aff. *irenae* Ganelina. Protvinsky Horizon, T-44 well, 4166-4171 m.

Fig. 13 – *Archaediscus glomus* Ganelina. Protvinsky Horizon, T-44 well, 4166-4171 m, bitumen-stained wall.

Fig. 14 – *Koskinobigenerina prisca* (Lipina). Protvinsky Horizon, T-44 well, 4155-4162 m, x 40.

Fig. 15 – *Cuneiphycus* sp. Protvinsky Horizon, T-44 well, 4192-4197 m, x 50.

Fig. 16 – *Globoendothyra globula* (Eichwald). Protvinsky Horizon, , T-44 well, 4166-4171 m.

Fig. 17 – *Asteroarchaediscus baschkiricus* (Krestovnikov & Theodorovich). Protvinsky Horizon, T-44 well, 4155-4162 m.

Fig. 18 – *Permodiscus* aff. *vetustus* Dutkevitch. Protvinsky Horizon, T-44 well, 4155-4162 m.

Fig. 19 – *Neoarchaediscus tumefactus* Ivanova. Protvinsky Horizon, T-44 well, 4155-4162 m.

Fig. 20 – *Mikhailovella*? sp. Early Serpukhovian, T-5050 well, 4139.60 m.

Fig. 21 – *Monotaxinoides transitorius* Brazhnikova & Yartseva. Protvinsky Horizon, T-17 well, 4890-4895 m.

Fig. 22, 23, 24 – *Turrispiroides subcarbonicus* (Dain). Serpukhovian. Fig. 22 – T-53 well, 5650.04-5650.16m; Fig. 23 – T-47 well, 4792.20 m; Fig. 24 – T-47 well, 4791.56 m.

Fig. 25 – *Monotaxinoides* cf. *subplanus* (Brazhnikova & Yartseva). Serpukhovian, T-47 well, 4793.23 m.

Fig. 26 – *Monotaxinoides priscus* Brazhnikova & Yartseva. Protvinsky Horizon, T-17 well, 4874-4781 m, x 100.

Fig. 27 – *Endostaffella discoidea* (Girty). Serpukhovian, T-53 well, 5600-5604 m.

Fig. 28 – *Neoarchaediscus akchimensis* (Grozdilova & Lebedeva). Protvinsky Horizon, T-44 well, 4155-4162 m.

Fig. 29 – *Howchinia* sp. Protvinsky Horizon, T-44 well, 4166-4171 m.

Fig. 30 – *Archaediscus moelleri* (Rauzer-Chernousova). Protvinsky Horizon, T-44 well, 4155-4162 m, bitumen-stained wall.

Fig. 31 – *Archaediscus grandiculus* (Shlykova). Protvinsky Horizon, T-44 well, 4197-4204 m, bitumen-stained wall.


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PLATE 6

Specimens housed in Building 5, Tengizchevroil Village, Atyrau Oblast, Kazakhstan. Magnifications x 75 except as indicated. Well locations shown in Fig. 2.

Fig. 1, 2, 3 - *Biseriella* of the group *B. parva* (Chernysheva). Fig. 1 – Protvinsky Horizon, T-44 well, 4148-4155 m; Fig. 2 – Serpukhovian, T-47 well, 5069.14 m; Fig. 3 – Protvinsky Horizon, T-44 well, 4166-4171 m.

Fig. 4 - *Globivalvulina* of the group *G. bulloides* (Brady). Protvinsky Horizon, T-17 well, 4890-4895 m, x 100.

Fig. 5, 6, 7, 8 - *Plectostaffella jakhensis* (Reitlinger). X 100. Fig. 5 – Protvinsky Horizon, T-44 well, 4192-4197 m; Fig. 6 – Protvinsky Horizon, T-17 well, 4874-4881 m; Fig. 7 – Late Syuransky Horizon, T-34 well, 4100-4105 m; Fig. 8 – Late Bashkirian, T-27 well, 3981-3988 m.

Fig. 9 - *Endotaxis brazhnikovae* (Bogush & Yuferev). Protvinsky Horizon, T-52 well, 5410.30-5410.35 m.

Fig. 10 - *Pseudoglomospira* sp. Serpukhovian, T-47 well, 4793.52 m.

Fig. 11, 15 - *Praedonezella cespeformis* Kulik. Serpukhovian, x 50. Fig. 11 – T-41 well, 4555-4561 m; Fig. 15 – T-47 well, 4795.60 m.

Fig. 12 - *Quasilituotuba* cf. *subplana "segmentata"* Brazhnikova. Protvinsky Horizon, T-44 well, 4166-4171 m.

Fig. 13 - *Palaeonubecularia rustica* Reitlinger. Protvinsky Horizon, T-52 well, 5410.30-5410.35 m, x 50.

Fig. 14 - *Millerella marblensis* Thompson. Earliest Bashkirian, T-34 well, 4121-4124 m.

Fig. 16 - *Saccaminopsis* sp. Serpukhovian, T-53 well, 5650.04-5650.16 m.

Fig. 17 - *Cribrostomum* cf. *eximiforme* Lipina. Late Syuransky Horizon, T-34 well, 4100-4105 m, x 50.

Fig. 18 - *Palaeoextularia vulgaris* (Reitlinger). Late Syuransky Horizon, T-34 well, 4100-4105 m.

Fig. 19 - *Palaeotextularia gibbosaeformis* (Reitlinger). Late Syuransky Horizon, T-34 well, 4100-4105 m.

Fig. 20 - *Millerella* sp. Earliest Bashkirian, T-34 well, 4121-4124 m.

Fig. 21 - *Eostaffella pseudostruvei* (Rauzer-Chernousova & Belyaev). Earliest Bashkirian, T-34 well, 4121-4124 m.

Fig. 22 - *Haplophragmina beschevensis* (Brazhnikova). Akavassky Horizon, T-34 well, 4069-4075 m.

Fig 23 - *Eostaffella* aff. *nauvalia* Rumyantseva. Late Bashkirian, T-27 well, 3981-3988 m.

Fig. 24 - *Eostaffella angusta* Kireeva. Late Bashkirian, T-27 well, 3981-3988 m.

Fig. 25, 26 - *Eostaffella* aff. *kashirica* Rauzer-Chernousova. Askynbashsky Horizon, T-220 well. Fig. 25 – 4083.10 m; Fig. 26 – 4082.72 m.

Fig. 27 - *Eostaffella* cf. *chomatifera* Kireeva. Late Syuransky Horizon, T-34 well, 4100-4105 m.

Fig. 28 - *Eostaffella* aff. *dolixa*? Manukalova. Late Syuransky Horizon, T-34 well, 4100-4105 m.

Fig. 29 - *Eostaffella postmosquensis acutiformis* Kireeva. Earliest Bashkirian, T-34 well, 4121-4124 m.

Fig. 30 - *Eostaffella* of the group *E. postmosquensis* Kireeva. Late Bashkirian, T-27 well, 3981-3988 m.

Fig. 31, 39 - *Pseudostaffella* sp. Fig. 31 – Askynbashsky Horizon, T-220 well, 4083.92 m; Fig. 39 – Late Bashkirian, T-27 well, 3975-3981 m.

Fig. 32 - *Beresella polyramosa* Kulik. Akavassky Horizon, T-3 well, 4697.05 m, x 50.

Fig. 33 - *Endothyra mosquensis* Reitlinger. Askynbashsky Horizon, T-220 well, 4083.10 m.

Fig. 34 - *Asteroarchaediscus rugosus* (Rauzer-Chernousova). Akavassky Horizon, T-16 well, 4866-4872 m, x 100.

Fig. 35 - *Donezella lutugini* Maslov. Akavassky Horizon, T-34 well, 4069-4075 m.

Fig. 36 - *Globivalvulina* of the group *G. granulosa* Reitlinger. Akavassky Horizon, T-34 well, 4068-4075 m.

Fig. 37 - ? *Eoschubertella mosquensis* (Rauzer-Chernousova). Askynbashsky Horizon, T-220 well, 4090.96 m, x 100.

Fig. 38 - *Archaediscus pseudomoelleri* Reitlinger. Akavassky Horizon, T-3 well, 4757.70 m, x100, bitumen-stained wall.

Fig. 40 - *Timanella* sp. Late Bashkirian, T-27 well, 3981-3988 m.

Fig. 41 - *Bradyina cribrostomata* (Rauzer-Chernousova & Reitlinger). Late Bashkirian, T-27 well, 3981-3988 m, x 40.

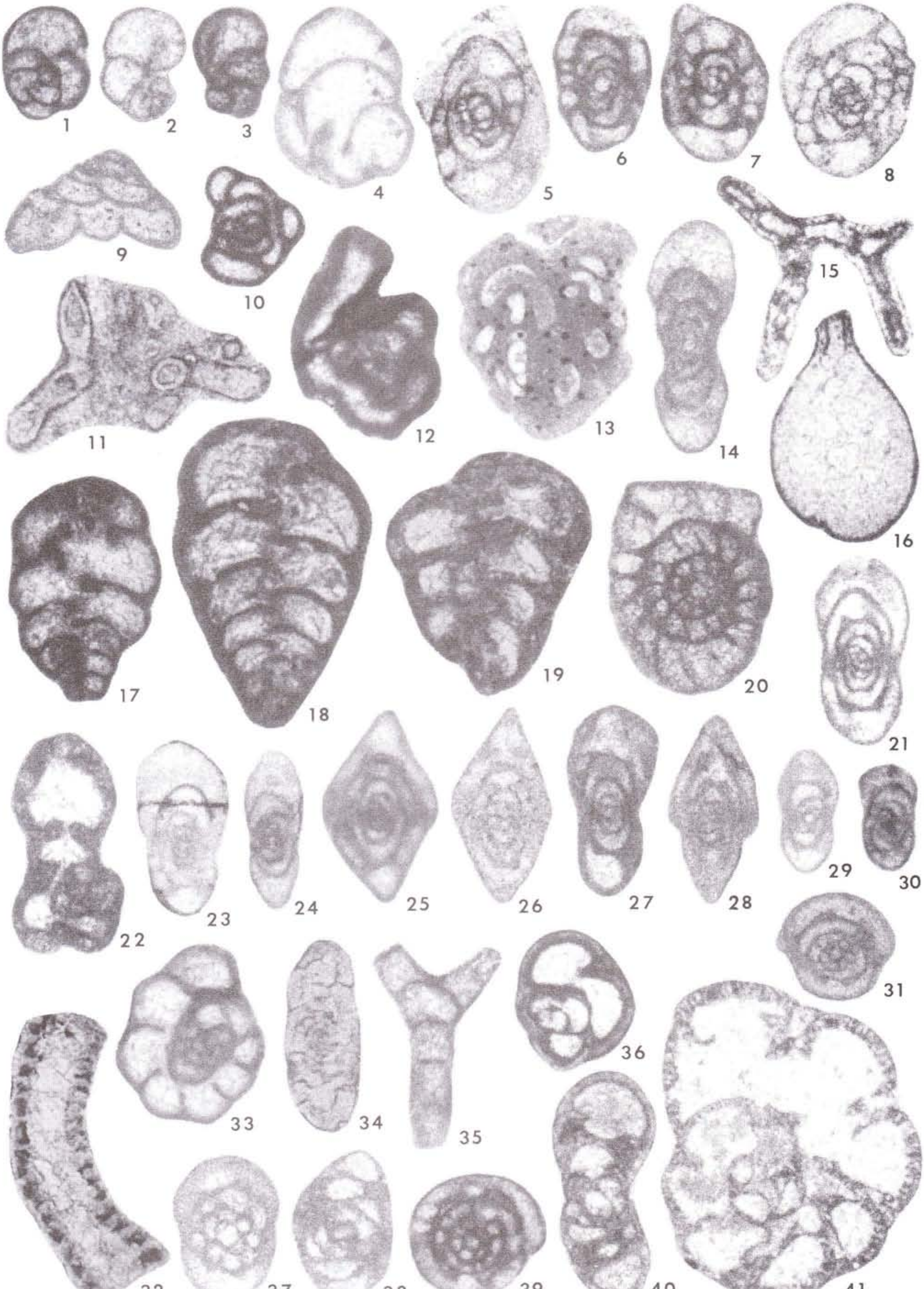
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PLATE 7

Specimens housed in Building 5, Tengizchevroil Village, Atyrau Oblast, Kazakhstan. Magnifications x 75 except as indicated. Well locations shown in Fig. 2.

Fig. 1, 2 - *Semistaffella variabilis* (Reitlinger). Fig. 1– Akavassky Horizon, T-34 well, 4069-4075 m; Fig. 2 – Late Syuransky Horizon, T-34 well, 4100-4105 m.

Fig. 3, 4 - *Pseudostaffella antiqua antiqua* (Dutkevitch). Akavassky Horizon, T-34 well, 4069-4075 m.

Fig. 5 - *Pseudostaffella* cf. *proozawai* Kireeva. Late Bashkirian, T-27 well, 3975-3981 m.

Fig. 6, 7 - *Pseudostaffella* of the group *P. compressa* (Rauzer-Chernousova). Late Bashkirian, T-27 well. Fig. 6 – 3981-3988 m; Fig. 7 - 3975-3981 m.

Fig. 8, 9, 10, 11, 12 - *Pseudostaffella* sp. Fig. 8 – Akavassky Horizon, T-34 well, 4069-4075 m; Fig. 9 – Akavassky Horizon, T-3 well, 4757.70 m; Fig. 10, 11 – Late Bashkirian, T-27 well, 3981-3988 m.; Fig. 12 -Akavassky Horizon, T-3 well, 4757.70 m.

Fig. 13, 18 - *Profusulinella* of the group *P. pararhomboides* Rauzer-Chernousova & Belyaev. Late Bashkirian, T-27 well, 3975-3981 m, x 45.

Fig. 14 - *Ozawainella* cf. *pararhomboidalis* Manukalova. Late Bashkirian, T-40 well, 4443-4444 m.

Fig. 15, 16 - *Ozawainella* of the group *O. fragilis* Safonova. Late Bashkirian, T-27 well, 3981-3988 m.

Fig. 17 - *Ozawainella* cf. *alchevskiensis* Potievska. Late Bashkirian, T-27 well, 3981-3988 m.

Fig. 19 - *Profusulinella* sp. Late Bashkirian, T-27 well, 3975-3981 m, x 40.

Fig. 20 - *Aljutovella*? sp. Late Bashkirian, T-27 well, 3975-3981 m, x 45.

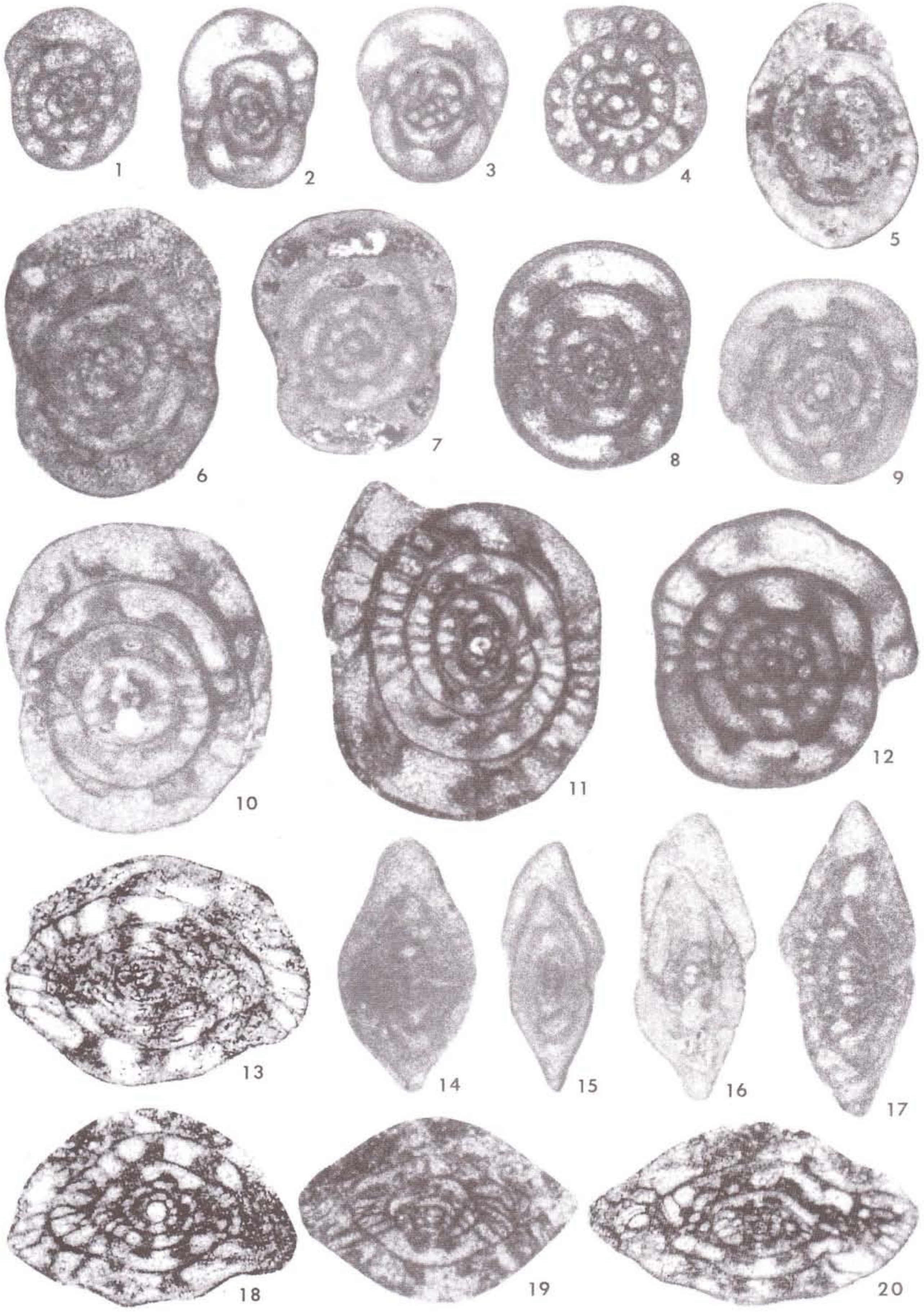
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Table 2 - Representative calcareous foraminifers, algae (A) and *incertae sedis* (IS) found on the platform top and slope at Tengiz (Figs. 2 and 3). Gumerovsky and Malevsky horizons contain unilocular and simple bilocular microfossil assemblages that are not listed in the table but mentioned in the text. Occurrences from basinal wells (T-52 and T-53), including Kosvinsky microfossils, are omitted although discussed in the text. See Table 1 for explanation of abbreviations.

↓ TAXON \ HORIZON or STAGE →	Fa	Up	Ch	Ki	Ra	Bo	Tu	A-V	T-S	Pr	B?-S	LS	Ak	As	LB
Eoendothyra baidjansaica (Bogush & Yuferev)	x														
E. bella? (Chernysheva)	x														
E. communis (Rauzer-Chernousova)	x														
E. lipinae (Mamet)	x														
E. turbida (Durkina)	x														
Issinella devonica Reitlinger (A)	x		x	x	x	x									
I. grandis Chuvashov (A)	x		x	x	x	x									
Kamaena awirsi Mamet & Roux (A)	x			x	x		x	x	x						
K. delicata Antropov (A)	x		x	x	x	x		x							
Menselina sp. (IS)	x														
Palaeoberesella lahuseni (von Möller) (A)	x		x		x	x		x		x					
Proninella sp. (A)	x														
Quasiendothyra sp.	x														
Q. kobeitusana (Rauzer-Chernousova)	x														
Q. dentata (Durkina)	cf.														
Rectoseptaglomospiranella asiatica (Reitlinger)	x														
Septaglomospiranella sp.	x	x	x	x	x										
S. compressa Lipina	x	x	x	x	x										
S. kingirica? Reitlinger	x														
S. primaeva "kazakhstanica" Reitlinger	x														
Eochernyshinella sp.		x													
Inflatoendothyra sp.		?													
Tournayellina sp.		x	x												
T. vulgaris Lipina		x													
Brunsia irregularis (von Möller)			x	x	x	x	x	x							
Chernyshinella sp.			x												
C. glomiformis (Lipina)			x												
C. paucicamerata Lipina			x												
Elergella simakovi Conil			cf.												
Inflatoendothyra parainflata (Bogush & Yuferev)			x	x	x	x									
Laxoendothyra parakosvensis (Lipina)			aff.	x											
Palaeospiroplectammina tchernyshinensis (Lipina)			x	x	x										
Pseudoglomospira sp.			x	x	x			x	x	x	x	x	x		
Spinoendothyra sp.			?	x	x	?									
Tournayella maxima Lipina			?	x											
Endospiroplectammina venusta (Vdovenko)				x											
Eoforschia moelleri (Malakhova)				cf.											
Eotournayella kisella (Malakhova)				x											
Glomospiranella sp				x											
Granuliferella latispiralis (Lipina)				x	x										
G. rjausakensis (Chernysheva)				x	x										
Latiendothranopsis grandis (Lipina)				cf.	x	x									
Neobrunsiina latispiralis (Lipina)				x											
Palaeospiroplectammina guttula (Malakhova)				x	x										
P. parva (Chernysheva)				cf.											
Parachaetetes sp. (A)				x											
Septaglomospiranella dainae Lipina				x											
S. primaeva (Rauzer-Chernousova)				x											
Spinoendothyra media (Vdovenko)				x	x										
S. paracostifera (Lipina)				x											
"S." paraukrainica (Lipina)				x											
"S." spinosa (Chernysheva)				x											
S. tenuiseptata (Lipina)				x											
Tournayella discoidea Dain				cf.											
Tuberendothyra tuberculata (Lipina)				x											
Urbanella urbana (Malakhova)				x	cf.										
Brunsia pulchra Mikhailov				x	x		x								
Uviella/Uvatournayella sp.				x											
Aphralysia capriorae Mamet & Roux (A)					x						x				
A. matthewsi Mamet & Roux (A)					x			x							
Asphaltinella sp. (IS)					x			x							
Bessiella sp.					x	x									
Dainella sp.					x										
D. chomatica (Dain)					x	x									
D. micula Postoyalkc					x										
Endochernella quaesita (Ganelina)					x										
Endospiroplectammina conili conili Lipina					x		x								

↓TAXON \ HORIZON or STAGE →	Fa	Up	Ch	Ki	Ra	Bo	Tu	A-V	T-S	Pr	B?-S	LS	Ak	As	LB
Endospiroplectammina conili lafoliensis Lipina					x	x									
Eoendothyranopsis donica Brazh. & Rostovtseva					x	x									
Eogloboendothyra sp.					x	x	x	x							
Eoparastaffella sp.					x	x									
E. rotunda Vdovenko					x	cf.									
E. ovalis Vdovenko					x										
E. simplex Vdovenko					x	x	x								
E. subglobosa Vdovenko					?										
Eotextularia diversa (Chernysheva)					x										
Granuliferelloides sp.					x										
Inflatoendothyra multispira (Simonova)					x										
Kamaena pirleti Mamet & Roux (A)					x			x							
Kamaenella tenuis (von Möller) (A)					x										
Koninckopora spp. (IS)					x	x	x	x	x	x					
Latiendothyranopsis paraconvexa (Brazh. & Rost.)					x	x									
Laxoendothyra laxa (Conil and Lys)					x										
L. pauli (Conil & Lys)					x										
"Loeblichia" fragilis (Lipina)					x	x									
Mediocris breviscula (Ganelina)					x	x	x	x	x	x	x	x	x		
M. mediocris (Vissarionova)					x	x	x	x	x	x					
Ninella staffelliformis (Chernysheva)					?										
Omphalotis sp.					x		x								
Palaeospiroplectammina sinensis (Lipina)					?	?									
Paradainella sp.					?										
"Priscella" sp.					x	x	x	x	x	x					
Pseudoammodiscus paraprimaevus Skvortsov					?		x								
P. priscus (Rauzer-Chernousova)					x	x	x	x	x	x					
Pseudolituotuba gravata (Conil & Lys)					x	x	x	x	x	x					
Pseudolituotubella septaglomospiroides (Vdov.)					cf.										
P. tenuissima (Vdovenko)					x	cf.									
Septabrunsiina krainica (Lipina)					x										
Spinolaxina pauli sensu Conil & Naum					cf.										
Tetrataxis sp.					x	x	x	x		x	x	x	x		
Endothyra bowmani Phillips						gp.	x	x	gp.	gp.					
Eoparastaffella simplex "lata"						x									
Epistacheoides sp. (A)						x	x	x							
Forschia subangulata (von Möeller)						cf.		x	x						
Globoendothyra sp.						x									
Glomodiscus sp.						x	x								
G. biarmicus Malakhova						x	x								
G. oblongus (Conil & Lys)						x	x, aff.								
Mametella sp. (A)						x		x		x					
M. chautauquae Brenckle (A)						x	x	x	x						
Omphalotis chariessa (Conil & Lys)						aff.		x							
O. frequentata (Ganelina)						x	x	x	x						
Paraarchaediscus sp.						x	x	x		x					
P. pauxillus (Shlykova)						?	aff.	x		cf.					
Pseudostacheoides sp. (A)						x	x								
Uralodiscus sp.						x									
U. adindanii Brenckle & Marchant						x									
U. rotundus (Chernysheva)						x									
Viseidiscus monstratus (Grozdilova & Lebedeva						x	x								
Aoujgalia sp. (A)							x	x							
Archaediscus moelleri (Rauzer-Chernousova)							gp.	x	x	x					
Biseriella bristolensis (Reichel)							?								
Coelosporella sp. (A)							x	x							
Consobrinella sp.							x	x	x	x	x	x	x		
C. consobrina (Lipina)							x	x	x	x		x			
Cribrostmum group *C. eximium sensu* von Möller							x		x						
Endostaffella delicata Rozovskaya							x	x	x	x					
E. discoidea (Girty)							x	x	x	x					
E. parva (von Möller)							x	x	x						
Endotaxis sp.							x		x	x					
Endothyra obsoleta Rauzer-Chernousova							x	x	x	x					
E. prisca Rauzer-Chernousova & Reitlinger							x		x						
E. similis Rauzer-Chernousova & Reitlinger							x	x							
Endothyranopsis compressa (Rauz.-Chern.& Reit.)							x	x	x						

↓ TAXON \ HORIZON or STAGE →	Tu	A-V	T-S	Pr	B?-S	LS	Ak
Eogloboendothyra aequiparva (Brenckle)	x						
Eoparastaffella ovalis Vdovenko	cf.						
Eostaffella sp.	x						
E. nalivkini (Malakhova)	x						
Eotextularia sp.	x						
Epistacheoides nephroformis Petryk & Mamet (A)	x	x					
Forschia sp.	x						
Fourstonella fusiformis (Brady) (A)	x	x					x
Globoendothyra globula (Eichwald)	x	x	x	x			
Glomodiscus deflectens (Conil & Lys)	aff.						
G. mixtus (Conil & Lys)	cf.						
Haplophragmella sp.	x	x		x			
Holkeria? sp.	?						
Kamaenella sp. (A)	x	x					
Koskinotextularia sp.	x	x	x	x			
Lituotubella glomospiroides Rauzer-Chernousova	x	x					
"Nodosarchaediscus" sp.	x	x		x			
Omphalotis circumplicata (Howchin)	x	x	x				
O. infrequentis (Shlykova)	x						
Palaeotextularia sp.	x				x	x	x
P. longiseptata (Lipina)	x	x	x	x		x	
Paraarchaediscus convexus (Groz. & Lebed.)	x	x	x	x			
P. dubitabilis Orlova	x						
P. infantis (Shlykova)	x						
P. inflatus (Shlykova)	aff.						
P. inflexus (Conil & Lys)	aff.						
P. koktjubensis (Rauzer-Chernousova)	aff.	x		x			
P. mellitus (Shlykova)	aff.						
P. ninae (Grozdilova & Lebedeva)	aff.						
P. pachytheca (Petryk)	x	cf.					
Planoarchaediscus sp.	x						
Plectogyranopsis convexa (Rauzer-Chernousova)	x	x	x	x			
Pojarkovella nibelis (Durkina)	x	x					
Pseudoendothyra sp.	x	x	x	x			
P. sagittaria (Shlykova)	aff.						
P. struvii (von Möller)	x	gp.		gp.	gp.		
Stacheoides sp. (A)	x	x		x			
S. meandriformis Mamet & Rudloff (A)	x						
S. tenuis Petryk & Mamet (A)	x						
Urbanella sp.	x						
Valvulinella sp.	x		x				
V. lata Grozdilova & Lebedeva	x						
V. tchotchiai Grozdilova & Lebedeva	x						
Viseidiscus primaevus (Pronina)	x						
Vissariotaxis exilis (Vissarionova)	x						
Archaediscus sp.		x		x	x		x
A. approximatus Ganelina		aff.					

↓ TAXON \ HORIZON or STAGE →	A-V	T-S	Pr	B?-S	LS	Ak	As	LB
Archaediscus enormis Shlykova	cf.							
A. gigas Rauzer-Chernousova	aff.	?						
A. krestovnikovi Rauzer-Chernousova	aff.	x			gp.			
Asphaltina cordillerensis Mamet (IS)	x							
Asteroarchaediscus sp.	x			x		x		
A. baschkiricus (Krestovnikov & Theodorovich)	cf.	gp.	x	gp.	gp.	gp.		
A. rugosus (Rauzer-Chernousova)	x	gp.	gp.	gp.	gp.	x		
Bradyina modica (Ganelina)	x							
B. nautiliformis? (von Möller)	gp.	gp.	gp.	gp.	gp.	gp.		
B. rotula (Eichwald)	x	x						
Brunsia lenensis Bogush & Yuferev	cf.							
Calcifolium okense Shvetzov & Birina (A)	x	x	x					
C. punctatum Maslov (A)	x							
Chantonia sp. (A)	x	x	x					x
Climacammina sp.	x	x			x	x		
C. antiqua (Brady)	gp.		gp.	gp.	gp.			
Cribrospira mira Rauzer-Chernousova	x							
Cribrostomum sp.	x		x		x			
C. eximiforme Lipina	x				cf.			
C. regulare Lipina	x		x					
Dainella? tujmasensis (Vissarionova)	x							
Donezella lutugini Maslov (A)	x	x		x	x	x		x
Endotaxis brazhnikovae (Bogush & Yuferev)	cf.	x	x		x	x		
Endothyranopsis crassa (Brady)	x	x	x					
E. sphaerica (Rauzer-Chernousova & Reitlinger)	x	x	x					
Eostaffella constricta Ganelina	x	x	x					
E. ikensis Vissarionova	gp.	gp.	gp.					
E. infulaeformis (Ganelina)	aff.		x					
E. mosquensis mosquensis Vissarionova	x	gp.	gp.	gp.				
E. mosquensis acuta Rauzer-Chernousova	x							
E. ovoidea (Rauzer-Chernousova)	x		x	x		x		
E. parastruvei (Rauzer-Chernousova)	x	x	x	x	?			
E. proikensis Rauzer-Chernousova	x	x	x					
E. raguschensis Ganelina	x							
E? settella Ganelina/*E? asymmetrica* (Rozovsk.)	x		x					
Fasciella kizilia Ivanova (IS)	x	x	x	x				
Globoendothyra ishimica (Rauzer-Chernousova)	x	x						
Haplophragmella fallax Rauz.-Chern. & Reitlinger	x							
H. tetraloculi Rauzer-Chernousova	x	?						
Haplophragmina beschevensis "angularis" (Brazh.)	x	x	x					
Howchinia sp.	x	x	x					
H. bradyana (Howchin)	x	x	x					
Janischewskina sp. (thin-walled)	x							
J. typica Mikhailov	x	x	x					
Koskinobigenerina sp.	x					x		
Koskinotextularia cribriformis Eickhoff	x		x					
Lituotubella magna (Rauzer-Chernousova)	x	x						

↓ TAXON \ HORIZON or STAGE →	A-V	T-S	Pr	B?-S	LS	Ak	As
Mirifica mirifica (Rauzer-Chernousova)	x	x	x				
Neoarchaediscus agapovensis Ivanova	x						
N. akchimensis (Grozdilova & Lebedeva)	x		x			x	
N. tumefactus Ivanova	x		x				
Omphalotis omphalota (Rauz.-Chern. & Reit.)	x	x	cf.				
O. pannusaeformis (Shlykova)	x						
Ortonella sp. (A)	x						
Palaeotextularia breviseptata Lipina	x						
Paraarchaediscus maximus (Groz. & Lebedeva)	x						
P. stilus (Grozdilova & Lebedeva	cf.	cf.					
Permodiscus vetustus Dutkevitch	x	x	aff.				
Plectogyranopsis regularis (Rauzer-Chernousova)	x	x	x				
Pojarkovella sp.	x	x	x				
P. pura Simonova	cf.						
Pseudoammodiscus volgensis (Rauz.-Chern.)	x	x	x				
Pseudoendothyra concinna (Shlykova)	cf.						
P. group *P. kremenskensis* Rozovskaya	x						
P. sagittaria (Shlykova)	?						
Rectocornuspira buskensis (Brazhnikova)	x						
Spinothyra pauciseptata (Rauzer-Chernousova)	x						
Stacheia sp. (A)	x	x	x		x	x	
indeterminate stacheiin (new genus?) (A)	x	x					
Tetrataxis pressula Malakhova	x		x				
Ungdarella sp. (A)	x		x			x	
Viseidiscus sp.	x						
Aphralysia sp. (A)		x				x	
Archaediscus inflatus Shlykova		x					
A. magnus Shlykova		x					
A. suppressus Shlykova		x	x				
Berestovia filaris Berchenko (IS)		x	x			x	
Betpakodiscus sp.		x					
Biseriella parva (Chernysheva)		gp.	gp.	gp.	gp.	gp.	
Consobrinella aspera (Cooper)		?	x				
Eostaffella gruenewaldti Malakhova		x		x			
Eostaffellina sp.		?	x	x			
Fourstonella sp. (A)		x	x	x		x	
Frustulata asiatica Saltovskaya (IS)		x	x				
Globotetrataxis elegantula (Brazhnikova)		x					
Haplophragmina beschevensis "*typica*" (Brazh.)		x	x	x	x	x	
Koskinobigenerina prisca (Lipina)		cf.	x				
Mediocris adducta (Durkina)		x					
Mikhailovella sp.		?					
"*Millerella*" *designata* Zeller		cf.	x		x	x	
Mirifica uchtovensis (Durkina)		x					
Monotaxinoides sp.		x	x			x	
M. cf. *declivis* (Ganelina)		x					
M. cf. *subplanus* (Brazhnikova & Yartseva		x					

↓ TAXON \ HORIZON or STAGE →	A-V	T-S	Pr	B?-S	LS	Ak	As	LB
Monotaxinoides transitorius Brazh. & Yartseva		cf.	x	x				
indeterminate multiseptate foraminifer		x						
Palaeonubecularia sp.		x	x	x	x			
P. uniserialis Reitlinger		x						
Planoendothyra sp.		x	x		x			
Plectostaffella sp.		x	x	x	x	x		x
Pojarkovella erigentis Simonova & Zub		cf.						
Praedonezella cespeformis Kulik (A)		x	x	x				
Rectoendothyra sp.		x	x					
syzygial cyst		x	x		x	x		
Archaediscus glomus Ganelina			x					
A. grandiculus Shlykova			x					
A. itinerarius Shlykova			x					
Asteroarchaediscus postrugosus (Reitlinger)			x		x	x		
Beresella/Dvinella sp. (A)			x		x			
Bradyina concinna Reitlinger			?					
B. cribrostomata (Rauz.-Chern. & Reitlinger)			x	x	x	x		x
Cribrostomum paraeximium Lipina			x					
Cuneiphycus sp. (A)			x					
Endothyra excellens (Zeller)			cf.					
E. phrissa (Zeller)			x					
Eolasiodiscus donbassicus Reitlinger			x		?			
Eostaffella angusta Kireeva			cf.	cf.	x			x
E. chusovensis Kireeva			x					
E. irenae Ganelina			aff.					
E. postmosquensis postmosquensis Kireeva			gp?	gp.	gp.	x		gp.
E. prisca (Rauzer-Chernousova)			x					
Eostaffellina actuosa Reitlinger			?					
E. paraprotvae (Rauzer-Chernousova)			x	x				
Exvotarsiella index (Ehrenberg *sensu* von Möll.) (A)			x					
Fasciella multiplex (Kulik) (IS)			x					
Forschiella prisca Mikhailov			x					
Globivalvulina bulloides (Brady)			gp.	gp.	gp.	gp.		
Globotetrataxis grandis (Brazhnikova)			x					
Janischewskina delicata (Malakhova)			x					
Kasachstanodiscus sp.			x					
"*Millerella*" *cooperi* Zeller			x					
Monotaxinoides priscus Brazhnikova & Yartseva			x					
Neoarchaediscus minimus (Reitlinger)			x			x		
N. probatus (Reitlinger)			x			x		
N. subbashkiricus (Reitlinger)			cf.		x	x		
Palaeonubecularia fluxa Reitlinger			x	x	x	x		
P. rustica Reitlinger			x	x	x			
Palaeotextularia lata (Chernysheva)			x					
Planoendothyra aljutovica (Reitlinger)			cf.	x		cf.		
P. spirilliniformis (Brazhnikova & Potievska)			x			x		
Plectostaffella jakhensis (Reitlinger)			x	cf.	x	x		

↓ TAXON \ HORIZON or STAGE →	A-V	T-S	Pr	B?-S	LS	Ak	As	↓ TAXON \ HORIZON or STAGE →	A-V	T-S	Pr	B?-S	LS	Ak	As	LB
Plectostaffella varvariensis (Brazh. & Potievska)			?	gp.	gp.			*Cuneiphycus texanus* Johnson (A)						x		
Pseudoendothyra illustria (Viss.)/*globosa* Roz.			x					*Deckerellina mirabilis* Reitlinger						x		
Quasilituotuba subplana "segmentata" Brazh.			cf.					*Donezella lunaensis* Rácz (A)						x		
Rectoendothyra latiformis (Brazhnikova)			x					*Endothyra mosquensis* Reitlinger						x	x	
Semiendothyra sp.			x	?	x			*Eostaffella amabilis* Grozdilova & Lebedeva						x		
Trepeilopsis sp.			x					*Glomospiroides fursenki* Reitlinger						x		
Turrispiroides multivolutus (Reitlinger)			x	x	x	x		*Haplophragmina kashirica* Reitlinger						aff.		
T. subcarbonicus (Dain)			x	x		x		*Millerella? paraumbilicata* Manukalova						x		
Archaediscus donetzianus Sosnina				x				*Ozawainella aurora* Grozdilova & Lebedeva						?		
A. variabilis Reitlinger				cf.				*Petschoria elegans* Korde (A)						x		
Beresella sp. (A)				x				*Pseudoendothyra timanica* (Rauzer-Chernousova)						cf.		
B. erecta Maslov & Kulik (A)				x				*P. variabilis* (Rauzer-Chernousova)						x		
B. polyramosa Kulik (A)				x		x		*Pseudostaffella* sp.						x		x
Eostaffella chomatifera Kireeva				x	x			*P. antiqua antiqua* (Dutkevitch)						x		
E. mirifica Brazhnikova				x	x			*P. antiqua grandis* Shlykova						x		
E. postmosquensis acutiformis Kireeva				x	x	x		*P. antiqua posterior* Safonova						x		
E. pseudostruvei (Rauz.-Chern. & Belyaev)				x		x		*P. compressa* (Rauzer-Chernousova)						gp.		gp.
Globivalvulina granulosa Reitlinger				gp?		gp.		*P. proozawai* Kireeva						?		cf.
Glomospiroides sp.				x				*P. ziganica* Sinitsyna						aff.		
Millerella sp.				x	x			*Semiendothyra surenica* Reitlinger						cf.		
M. marblensis Thompson				x				*Semistaffella minor* (Rauzer-Chernousova)						x		
Palaeotextularia gibbosaeformis (Reitlinger)				x	x	x		*Uraloporella variabilis* (A)						x		
Pseudoendothyra circuli (Thompson)				x				*Eoschubertella* sp.							x	
Semistaffella sp.				?	x			*?E. mosquensis* (Rauzer-Chernousova)							x	
Stacheia pupoides Brady (A)				x				*E. kashirica* Rauzer-Chernousova							aff.	
Uraloporella sp. (A)				?				*Profusulinella parva* (Lee & Chen)							gp.	
Archaediscus pseudomoelleri Reitlinger					cf.	x		*Pseudostaffella praegorskyi* Rauzer-Chernousova							x	
Climacammina fragilis Reitlinger					x	cf.		*Staffellaeformes staffellaeformis* (Kireeva)							gp.	
Eostaffella dolixa? Manukalova					aff.			*Aljutovella sp.*								?
E. pinguis (Thompson)					x			*Eostaffella nauvalia* Rumyantseva								aff.
Fasciella sp. (IS)					x			*Ozawainella alchevskiensis* Potievska								cf.
Masloviporidium delicatum (Berchenko) (A)					x	x		*O. fragilis* Safonova								gp.
Millerella uralica Kireeva					aff.	x		*O. pararhomboidalis* Manukalova								cf.
Palaeotextularia vulgaris (Reitlinger)					x	x		*O. pogorevichi* Rauzer-Chernousova								aff.
Semistaffella variabilis (Reitlinger)					x	x		*Profusulinella* sp.								x
Archaediscus longus Potievska						x		*P. pararhomboides* Rauz.-Chern. & Belyaev								gp.
A. ovoides Rauzer-Chernousova						?		*Seminovella* sp.								x
A. timanicus Reitlinger						x		*Timanella* sp.								x