50 years University of Mining and Geology "St. Ivan Rilski"
Annual, vol. 46, Part I, Geology and Geophysics, Sofia, 2003, pp.25-30

EARLY CRETACEOUS DEVELOPMENT OF THE MOUNTAUN CRIMEA

E. Baraboshkin

M.V. Lomonosov Moscow State University, Barabosh@geol.msu.ru

ABCTRACT

Recent studies of the Crimea give us new data for the interpretation of Early Cretaceous history of the region, which differs from the previous data. Shortly, it could be established as following. (1) The compression and later extension in the latest Berriasian – E. Valanginian resulted in the formation of complex graben system. The Plain Crimea was an uplift; the basin deepen to the S and the Mountain Crimea was mostly submerged. (2) L. Valanginian – E. Hauterivian phase was marked by the northward tropical sea transgression and formation of complex facial system in slow extensional conditions. (3) During the L. Hauterivian – Aptian the whole area quickly subsided. The Mountain Crimea was overlapped by uniform pelagic facies. The sea covered Plain Crimea almost completely and Boreal water mass reached this area in the Late Hauterivian. (4) The new uplift and folding event of the Mountain Crimea took place in the E. – M. Albian. In contrast, back-arc rift system was formed in the Plain Crimea, where volcanic sediments appeared. (5) During the latest M. Albian – L. Albian rifting event and a series of transgressions lead to the submersion of the Mountain Crimea and possibly to the Black Sea opening.

INTRODUCTION

Lower Cretaceous deposits of the Mountain Crimea is a complex object for investigation because of the facial variability and polyphase tectonic activity. So, there is no uniform view on the structure and geological history of the region even if its investigations have been started a long time ago.

The most complete "classic" summary on the Lower Cretaceous of the Mountain Crimea was published in several monographs: by N.I.Karakasch (1907), V.V.Drushchits et al. (Drushchits, Kudryavtsev, 1960) and M.V.Muratov et al. (1969). Since that time new discoveries in geology and stratigraphy of the Lower Cretaceous of the Mountain Crimea (Arkadiev et al., 1997, 2000; Baraboshkin, 1997a-b, 2001; Baraboshkin, Mikhailova, 1994, 2000; Baraboshkin, Yanin, 1997; Bogdanova et al., 1981; Yanin, Vishnevsky, 1989; etc.) were made. Additionally, many geological objects not aloud for investigations during Soviet time start to be available for the visits. These facts together with new sedimentological and tectonical concepts make possible to revise geological history of the region.

STRATIGRAPHY

Lower Cretaceous deposits are exposed along the First and (mainly) Second Range of the Crimea Mountains (fig.1). Their completeness and composition are very different in different parts of the region. Because of it several sections were proposed as reference sections for the whole Lower Cretaceous succession.

Study of these and other sections made possible to work out a detailed biostratigraphic scheme for the Mountain Crimea (table).

Lower Berriasian is well exposed and paleontologically characterized by fauna in pelagic limestone-marly facies of Theodosia section (fig.1: loc.4). It was described by O.Retowski (1893) and restudied in numerous publications (Bogdanova et al., 1981; Kvantaliani, 1989, etc.).

Upper Berriasian is well-documented in a shallow-water carbonate to terrigenous facies of Balki – Pasechnoe Village sections (fig.1: loc.3), near Belogorsk City. It was described details by T.N.Bogdanova et al. (Bogdanova, Kvantaliani, 1983; Bogdanova et al., 1981; Kvantaliani, 1989, etc.).

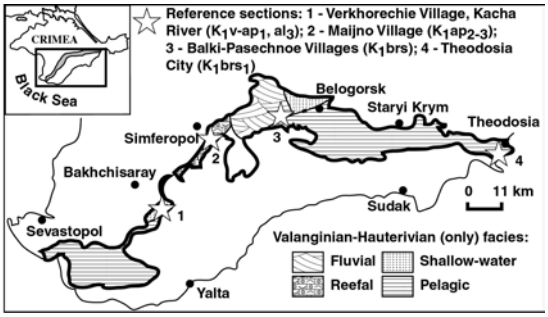

Figure 1. Distribution of the Lower Cretaceous in the Mountain Crimea (thick line), reference sections and main types of facies for the Valanginian – Hauterivian time

The best Valanginian - Lower Aptian shallow- to deep water terrigenous succession is located in Kacha River basin, near Verkhoirechie Village (fig.1: loc.1). After the work of N.I.Karakash (1907) this section was described for many times (Drushchits, Kudryavtsev, 1960; Yanin, Vishnevsky, 1989, etc.). The latest revision of the section was published recently by the author (Baraboshkin, 1997a-b, 2001).

Middle-Upper Aptian pelagic clays are badly exposed with the exception of Simpheropol City region, where they were studied in the Marjino Village quarry (fig.1: loc.2) by V.V.Drushchits et al. (1981).

The existence of the uppermost Aptian - Lower Albian deposits in the Mountain Crimea is very probable. Normally this interval is missing due to the folding event. Uppermost Middle Albian sections are known in Balaklava City (near Sevastopol) region, but they need further examination.

STAGE	SUBST.	"STANDARD" ZONATION OF WESTERN MEDITERRANEAN (HOEDEMAEKER, RAWSON, 2000) ZONE, SUBZONE		MOUNTAIN CRIMEA (BARABOSHKIN, 2001) ZONE, SUBZONE, BEDS WITH FAUNA	
ALBIAN	UPPER	Stoliczkaia dispar	Stoliczkaia dispar	Mortoniceras perinflatum	
			Stoliczkaia blancheti	Mortoniceras rostratum	
		Mortoniceras inflatum		Mortoniceras inflatum	
				Hysteroceras varicosum	
				Hysteroceras orbignyi	
			Dipoloceras cristatum		
	MIDDLE	Euhoplites lautus		Anahoplites daviesi	
		Euhoplites loricatus			
		Hoplites dentatus	Hoplites spathi	MISSING	
			Lyelliceras lyelli		
		Douvilleiceras mammillatum			
		Leymeriella tardefurcata		? Leymeriella tardefurcata	
APTIAN	UPPER	Hypacanthoplites jacobi		MISSING	
		Nolaniceras nolani			
			Diadach. nodosocostatum	? Nolaniceras nolani	
	MIDDLE	Parahoplites melchioris		?	?
					Acanthohoplites aschiltaensis
					Parahoplites multicostatus
		Epicheloniceras subnodosocostatum		Aconeceras nisum	Colombiceras crassicostatum
	LOWER	Dufrenoya furcata		Aconeceras nisoides	?
		Deshayesites deshayesi			Deshayesites deshayesi
		Deshayesites weissi			?
		Deshayesites tuarkyricus			
BARREMIAN	UPPER	Pseudocrioceras		Patruliusiceras uhligi	
		Colchidites sarasini			
		Imerites giraudi			
		Hemihoplites feraudianus			
		Gerardthia sartousiana	Gerardthia provincialis	Gerardthia provincialis	
			Gerardthia sartousiana		
		Ancyloceras vandenheckii			
	LOWER	Montoniceras moutonianum		Holcodiscus caillaudianus	
		Kotetishvilia compressissima			
		Kotetishvilia nicklesi		Niklesia pulchella	
		Avramidiscus hugii		Taveraediscus hugii	
HAUTERIVIAN	UPPER	Pseudothurmannia angulicostata auctorum	Pseudothurmannia catulloi	Pseudothurmannia catulloi	
			P. angulicostata auct.	Pseudothurmannia ohmi	
		Balearites balearis		Milanowskia speetonensis	
		Plesiospitidiscus ligatus		Speetoniceras inversum	
		Saynella sayni		Crioceratites duvali	
	LOWER	Lyticoceras nodosoplicatum		Lyticoceras nodosoplicatum	
		Crioceratites loryi	Olcostephanus jeannoti	? Crioceratites loryi	
			Crioceratites loryi		
		Acanthodiscus radiatus		Leopoldia desmoceroides	
VALANGINIAN	UPPER	Teschenites callidiscus		Eleniceras tauricum	
				Teschenites callidiscus	
		Himantoceras trinodosum	Criosarasinella furcillata	Himantoceras trinodosum	
			Olcostephanus nicklesi		
		Saynoceras verrucosum	Vahrleideites peregrinus	Neohoploceras submartini	? Vahrleideites peregrinus
			Karakasch. pronecostatum		?
			Saynoceras verrucosum		
	LOW.	Busnardoites campylotoxus		Campylotoxia campylotoxa	
		Thurmanniceras pertransiens		Thurmanniceras pertransiens	
		Thurmanniceras otopeta		Kilianella otopeta	
BERRIASSIAN	UPPER	Fauriella boissieri	Tirnovella alpillensis	Megadiceras koinautense Beds	
				Weberithyris moisseevi Beds	Zeillerina baksanensis Beds
					Symphythyris arguinensis Beds
			Berriasella picteti		Tauricoceras crassicostatum
			Malbosiceras paramimounum	Euthymiceras euthymi	
	LOWER	Tirnovella occitanica	Dalmasiceras dalmasi	Dalmasiceras tauricum	
			Berriasella privasensis	Tirnovella occitanica	
			Tirnovella subalpina		
		Berriasella jacobi		Pseudosubplanites ponticus	

At last, the Upper Albian ingressive and shallow-marine facies were described by B.T.Yanin (1976), R.Marcinowski and D.P.Naidin (1976) in Prokhladnoe Village region, not far from the Kacha River section (fig.1: loc.1).

Distribution of different fossils (ammonites, belemnites, bivalves, brachiopods, forams, etc.) was studied for the mentioned sections, but only two biostratigraphic scales covering the whole Lower Cretaceous interval were developed for the region. They are based mainly on ammonites (Baraboshkin, 2001: see the table) and foraminifers (Gorbachik, 1986).

Ammonite scale is quite detail, but it combines ammonites of different ecological position: mostly neritic nectobenthic, but also shallow to deep-water pelagic hemiplanktonic (according to classification of Westermann, 1996). Moreover, most of them are Tethyan, but some endemics and even Boreal (lower Upper Hauterivian). In case of uppermost Berriasian ammonite indexes were not found. It is the reason of using rudists and brachiopods for biostratigraphy as index fossils for carbonate platform facies of this interval. Such kind of biostratigraphic set reflects complex geological history of this part of the world with episodes of uplifts, deepening, isolation and Boreal water mass influence.

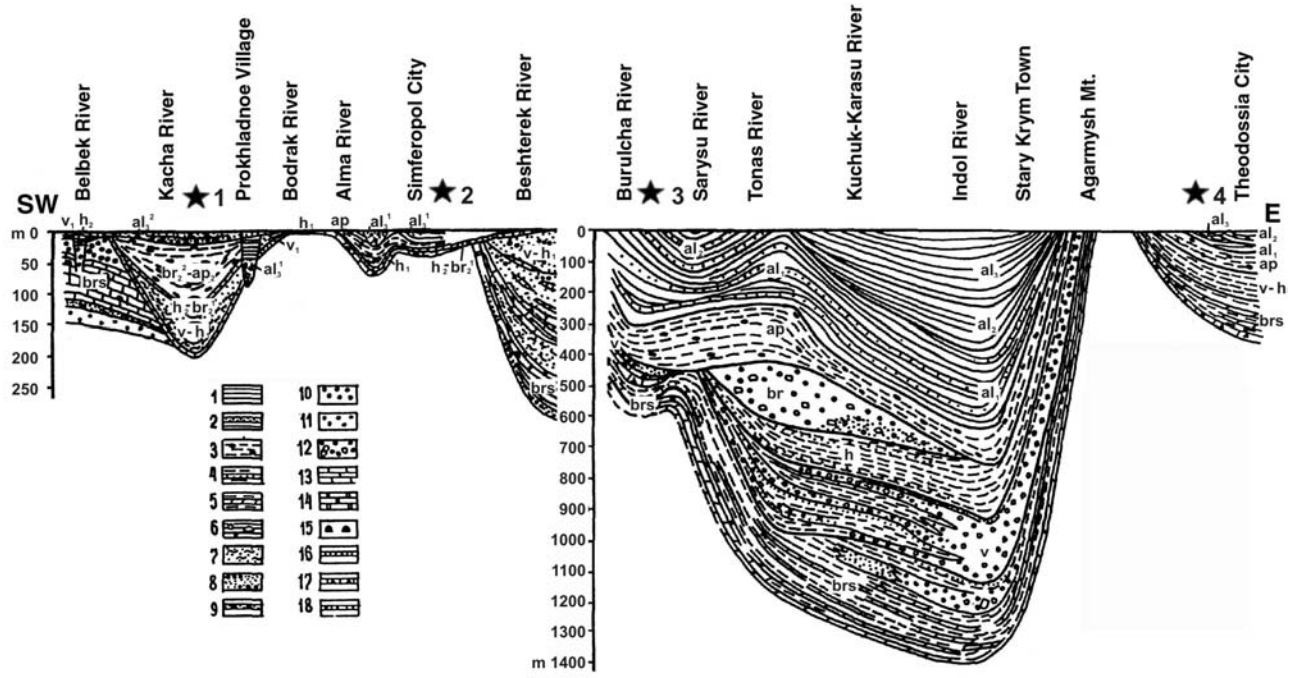

Figure 2. The Lower Cretaceous of the Mountain Crimea (after Nikishin et al., 1993, modified). Stars mark the position of reference sections (1 to 4), figured on fig.1. 1 - black clays (al); 2 - alternation of clays and sandstones; 3 - clays with ankerites (ap); 4 - clays with sandstone beds (brs, v, h); 5 - alternation of clays and marls (br_1); 6 - clays with boulders (al_2^1); 7 - siltstones and sandstones (brs-h_1); 8 - alternation of soft and hard sandstones; 9 - sandstones (v-h); 10 - quartz conglomerates (brs_2); 11 - polymict conglomerates (brs_1); 12 - conglomerates (brs-h); 13, 14 - biogenic limestones (brs_{1-2}); 15 - coral - algal bioherms (brs, h_1); 16 - cephalopod limestones (h_2-br_2); 17 - breccied limestones (brs_1); 18 - "pudding" conglomerates and sandstones (v)

Major paleogeographic features

Lower Cretaceous basin of the Mountain Crimea consists of two major "bathes", opened to the south: western, shallow-water with lower thickness of deposits, and eastern – deeper-water with thick succession (fig.2). The deposition in both regions was controlled by (1) climatic changes, (2) local block movements and (3) major tectonic events in the Peri-Tethyan area. Climatic control is reflected in the style of sedimentation: carbonate in the Berriasian and mainly terrigenous in Valanginian – Albian. Block movements affected depth and rate of sedimentation.

Depth changes were determined recently (Enson, Baraboshkin, 2002) by the calculation of siphonal and septal strength indexes of ammonites (fig.3) using the technique of R.A.Hewitt and G.E.G.Westermann (1990) with facial, ichnofossil and paleoecological control.

The Early Berriasian in the Crimea – Caucasus region was characterised by separation of the Boreal Basin and the Tethys. The arid climate led to carbonate sedimentation in the Crimea – North Caucasus - Kopet-Dagh area and formation of an evaporate belt to the north (Baraboshkin, 2001). In the Mountain Crimea Berriasian deposits together with Upper Jurassic carbonates participate in the structure of carbonate platform of the First Range. Deeper-water clayey – carbonate facies of destroyed platform margin fill the eastern Crimea basin.

The Early/Late Berriasian transition is marked by a interruption of carbonate sedimentation and deposition of the clastic facies almost everywhere in the Mountain Crimea. Short-term deformations took place in the terminal Berriasian, just before the Barriasian / Valanginian boundary. During this stage the First Range was compressed, uplifted and affected by the block movements (Mileev et al., 1998). Some of these blocks were consequently eroded. The compressional phase changed into extensional just before the Valanginian, which led to formation of graben systems.

During the Early Valanginian terrigenous lacustrine to near-shore sediments (fig.1, 2) cover the Mountain Crimea (Baraboshkin, Yanin, 1997). They lay with structural unconformity and fill karst cavities in the Upper Jurassic – Berriasian carbonates. The outer part of the First Range was submerged and pelagic clays deposited there.

Early Hauterivian was the time of developed transgression, which covered the whole Mountain Crimea (Baraboshkin, 1997a, b, 2001). The terrigenous marine to near-shore sandy facies was present in central Crimea and in the Kacha River reference section in particular (fig.1, 2). They were divided from the Simferopol uplift to the north by a narrow belt of small coral reef buildups. These buildups replaced by lacustrine to near-shore facies to the east and controlled by block movements. The area of the first Crimea range was submerged and clay sedimentation took place there. The age of the succession is confirmed by the presence of ammonite genera *Leopoldia*, *Breistrofferella*, *Lyticoceras* and some of *Crioceratites* (table).

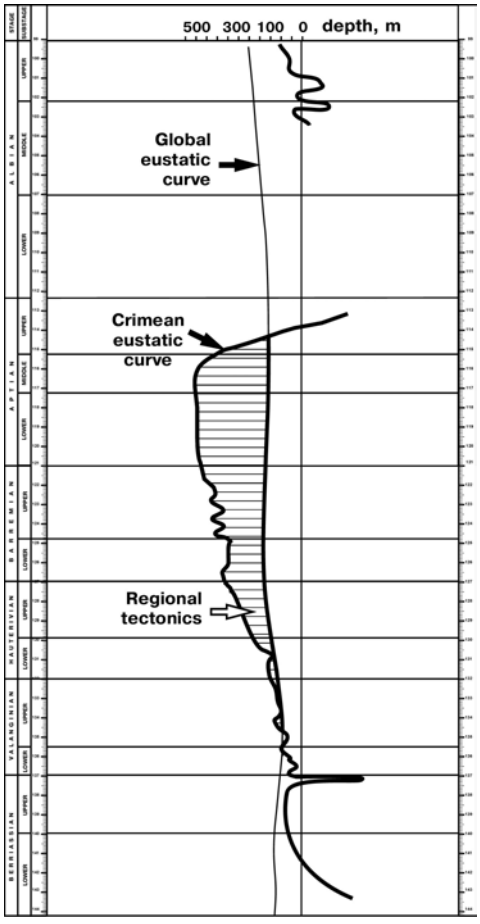

Figure 3. Calculated depth of the Early Cretaceous basin in the Kacha – Bodrak watershed, Bakhchisaray Town region (Baraboshkin, 2001; Enson, Baraboshkin, 2002). Difference between Crimean eustatic curve and Global eustatic curve reflects the regional tectonic component

Unlike the Early Hauterivian, the Late Hauterivian was the period of the strongest Boreal transgression (Baraboshkin, 2001, 2002), which covered almost the complete studied area. This fact is confirmed by the presence of mixed Tethyan – Boreal ammonite and bivalve assemblages in the SW of Mountain Crimea (Kacha reference section), which contain *Speetoniceras, Simbirskites, Milanovskia* and *Heteropteria* (see the table) together with *Melchiorites, Paraspiticeras, Anahamulina*, etc. The transgression penetrated into Plain Crimea (Leschukh, 1987), where terrigenous sedimentation started. In Mountain Crimea highly condensed "Ammonitico Rosso" facies were formed and in the outer part of the basin clayey sedimentation took place (Baraboshkin, 1997b).

The Barremian palaeogeography is characterised by further transgression in the Plain Crimea, where terrigenous Barremian sediments overlay Hauterivian and older deposits (Leschukh, 1987). In Mountain Crimea they partially represented of the upper part of "Ammonitico Rosso" limestones and partially – the lower part of the deep-water clayey sections (Yanin, Vishnevsky, 1989; Baraboshkin, 1997a). Block movements led to the appearance of the thick olistostrom member in the Eastern Crimea.

During the Aptian pelagic clays were deposited all over the Mountain Crimea under disoxic conditions. Ammonites are very rare and the age of the clays is mainly determined by the foraminiferal data (Gorbachik, 1986). The Kacha River reference section is very typical for Mountain Crimea.

Uppermost Aptian is missing in the succession because of the new stage of deformations and tectonical uplift of the region (Yanin, Vishnevsky, 1989; Baraboshkin, 2001). During the Early – Middle Albian the most part of the Mountain Crimea was a dryland. Stratigraphy of the Lower – Middle Albian in the Eastern Crimea needs further investigations. In the Plain Crimea shallow sea with terrigenous sedimentation has developed in the Early Albian (Leschukh, 1987). In the Middle Albian volcanogenic sedimentation started in the Karkinit back-arc basin of the Plain Crimea (Nikishin et al., 1997).

The latest Middle Albian – early Late Albian was marked by mixed estuarine – shallow-water sedimentation in the Second Range. The sea ingressed in the palaeovalleys of Mountain Crimea from the north and north-west and filled them with clays and sands (Yanin, Vishnevsky, 1989).

An extension event took place in the Crimea-Caucasus region during the latest Albian – Cenomanian. The sea transgressed onto the Mountain Crimea from the south. Carbonate sedimentation started again, but on the south-west (Sevastopol region) and in the north (Karkinit basin) a strong influence of pyroclastics is occurred. The pike of volcanic activity falls on the Albian / Cenomanian boundary, because pyroclastic rocks covers the whole Crimea. It is supposed that this magmatic event was connected with the Black Sea origin (Nikishin et al., 1997).

CONCLUSIONS

As could be seen from this short review, the Early Cretaceous history of the Mountain Crimea is very complex. Intensive study of Lower Cretaceous deposits during the last years led to recognition of a series important events. (1) Determination of the Valanginain in the shallow-water and

lacustrine facies (Baraboshkin, Yanin, 1997) made possible to define the time of extensional event, characteristics of block movements and to separate Early Hauterivian complex facial paragenesis from the Valanginian, more slmple paleogeography; (2) to quantify depth changes for the Early Cretaceous and to recognise sudden deepening of the Mountain Crimea basin on the Early / Late Hauterivian boundary (Baraboshkin, 2001; Enson, Baraboshkin, 2002); (3) to determine more precisely (Latest Albian) the beginning of the extension phase of back-arc system for the SW Crimea.

There are, however, a lot of questions waiting for further study.

ACKNOWLEDGEMENTS

The research was done with the support of RFBR foundation (Projects 01-05-64641, 01-05-64642, 01-05-64788).

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