

## *Biostratigraphic characterization of Lower Jurassic deposits of Georgia by ammonites*

### *Caracterización bioestratigráfica de los materiales del Jurásico Inferior de Georgia por medio de ammonites*

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#### ABSTRACT

The Lower Jurassic deposits playing important role in the geological structure of Georgia are considered here according to structural-facial zones. The characteristic of each zone is accompanied by description of the most typical and paleontologically well-substantiated lithological-stratigraphic units. The paper also argues the problem of interrelation between Lower Jurassic and underlying Devonian-Triassic formations. On the ground of Ammonite associations the presence of nearly all Lower Jurassic stages, several zones of standard scale and also regional stratigraphic subdivisions has been recognized.

**Key words:** Lower Jurassic, Ammonite associations, Biostratigraphy, Caucasus, Georgia.

#### RESUMEN

Los materiales del Jurásico Inferior de Georgia presentan una gran importancia en el contexto de la estructura geológica de este país. En el presente trabajo se estudian estos materiales subdividiéndolos en zonas de carácter facial-estructural. Los rasgos particulares de cada zona se acompañan de la descripción de las unidades litoestratigráficas más típicas y mejor justificadas

por datos paleontológicos. Se discute asimismo la problemática de la interrelación entre las unidades del Jurásico Inferior y las formaciones subyacentes del Devónico-Triásico. El análisis de las asociaciones de ammonites ha permitido caracterizar la presencia de la mayoría de los pisos del Jurásico Inferior; algunas de las zonas de la escala estratigráfica estándar, y algunas subdivisiones estratigráficas regionales de carácter más local.

**Palabras clave:** Jurásico Inferior, Asociaciones de ammonites, Bioestratigrafía, Cáucaso, Georgia.

## INTRODUCTION

The Lower Jurassic deposits are developed irregularly on the territory of Georgia. Their outcrops are rather widespread within the Fold system of the Greater Caucasus - in the Main Range, Kazbegi-Lagodekhi, Chkhaltá-Laila and Gagra-Djava zones (Gamkrelidze, 1984) (Fig. 1). They are somewhat less spread within the Transcaucasian intermontane area - Georgian Block (Dzirula massif) and within the Fold system of the Lesser Caucasus - in the Artvin-Bolnisi (Khrami massif) and Locki-Karabakh (Locki massif) structural-facial zones. These deposits are represented by various facies with all the intermediate varieties - from deep-water marine to coastal and continental. Magmatic activity has been proceeded in both effusive and intrusive forms.

The Lower Jurassic deposits contain a wide range of valuable minerals, both ore and non-metallic that have important practical application. Consequently, it is quite clear the great interest revealed by many investigators towards these deposits the stratigraphic study of which has more than a centenarian history in Georgia.

The investigations of the first period had episodic character and actually were very general by nature. Due to the extremely rare finds of fossils the subdivision of the Lower Jurassic sediments was based mainly on lithological features and stratigraphic succession.

The beginning of a systematic study of the Lower Jurassic stratigraphy in Georgia was based by works of Gamkrelidze (1933, 1940), Djane-Lidze (1946), Kakhadze (1947), Nutsbidze (1972) and others. The author of the present paper has led, for many years, systematic works on detail stratigraphic differentiation of Lower Jurassic deposits based on monographic studies of Ammonite assemblages. New finds of Ammonites allowed us to define more exactly the stratigraphy of these deposits and to establish, for the first time, their belonging to certain stratigraphic levels of the standard scale<sup>1</sup>.

<sup>1</sup> This scale was compiled with due regard for the results of the International colloquiums in Luxemburg (1962, 1976), Moscow (1967), Budapest (1969), Stuttgart (1977), etc. (see Decision..., 1978 and The Jurassic..., 1982).

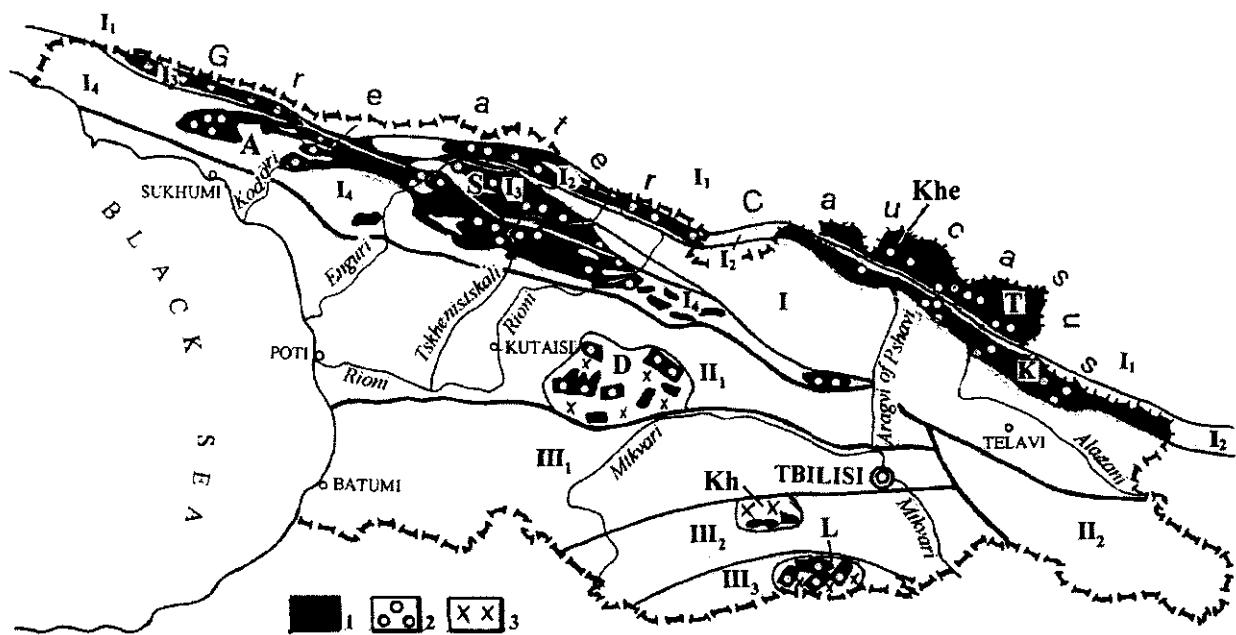


FIG. 1.—Distribution of Lower Jurassic deposits and Ammonite fossils on the territory of Georgia. 1—outcrops of Lower Jurassic deposits; 2—localities of finds of Ammonite fossils; 3—outcrops of the ancient basement. I—Fold system of the Greater Caucasus; II—Main Range zone; I2—Kazbegi-Lagodekhi zone; I3—Chkhaltal-Laila zone; I4—Gagra-Djava zone; II—Transcaucasian intermontane depression; II1—Georgian block, II2—Kura intermontane basin; III—Fold system of the Lesser Caucasus; III1—Adjara-Trialetian fold zone; III2—Artvin-Bolnisi block; III3—Locki-Kara-bakh zone. A—Abkhazia; D—Dzirula massif; K—Kakheti; Kh—Khrami massif; Khe—Khevsureti; L—Locki massif; S—Svaneti; T—Tusheti.

FIG. 1.—Distribución de los materiales del Jurásico Inferior y de los principales yacimientos de ammonioideos en el territorio de Georgia. 1: Afloramientos de materiales del Jurásico Inferior; 2: Puntos o localidades de registro de ammonites; 3: Afloramientos del basamento inferior, paleozoico-triásico. I.— Sistema de pliegues del Gran Cáucaso: I.1 Zona de la Cordillera Principal; I.2: Zona de Kazbegi-Lagodekhi; I.3: Zona de Chkhaltal-Laila; I.4: Zona Gagra-Djava; II. Depresión intramontana transcaucásica: II. 1: Bloque georgiano; II.2: Cuenca intermontana de Kura. III: Sistema de pliegues del Pequeño Cáucaso. III.1: Zona de pliegues de Adjara-Trialet; III.2: Bloque de Artvin-Bornisi; III.3: Zona de Locki-Karabakh. A: Abkhazia; D: Macizo de Dzirula; K: Kakheti; Kh: Macizo de Khrami; Khe: Khevsureti; L: Macizo de Locki; S: Svaneti; T: Tusheti.

## SINEMURIAN DEPOSITS

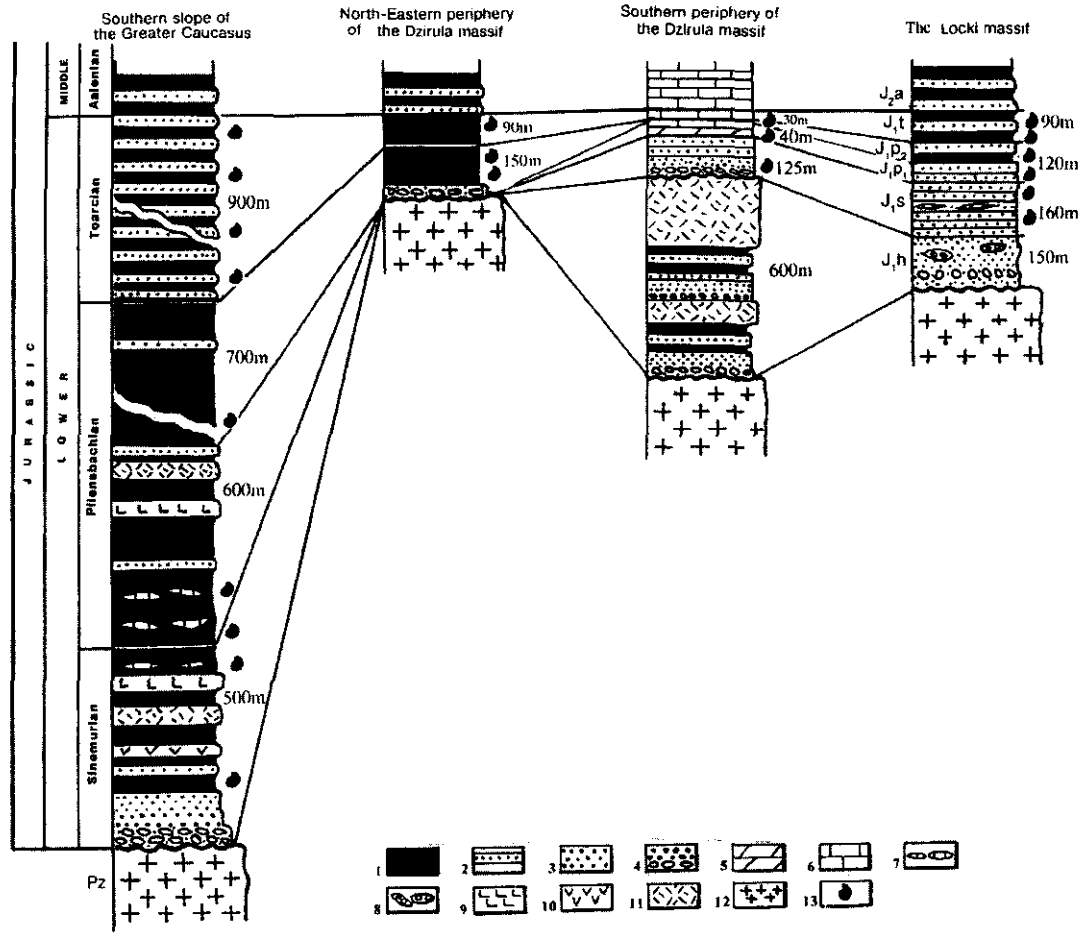
The most ancient sediments containing ammonite remains are of Sinemurian age (Fig.2). They are widespread within the Southern slope of the Greater Caucasus. Here, in the north-western part, in the territory of Abkhazia Sinemurian deposits make up the Chkhalta-Laila zone. Here, they transgressively overlie the Paleozoic basement. By their granulometric composition Sinemurian deposits can be divided into two parts. The lower one is represented by conglomerates, gravelites, coarse-grained sandstones and sandy-aleurolitous shales 50-150 m thick. The upper part is mainly made up of the interchange of shales, sandstones and aleurolites with rare intercalations of gravelites and conglomerates with total thickness up to 450 m. Volcanogenic rocks of this sequence form the flows of quartzkeratophyres and, less frequently, thin layers of their tuffs. In shales and sandstones have been found numerous Bivalve and some ammonites-*Vermiceras aff. scylla* (Reyn.), *Epideroceras cf. steinmanni* (Haug) and *Oxynoticeras sp.* (Bukia, Kolosovskaya & Abamelik, 1971). The finds of these ammonites give evidence of the presence of both lower and upper substages of the Sinemurian stage. To the south, in the Gagra-Djava zone, Sinemurian deposits are exposed in the core of the large Chedim anticlinal fold. They consist of fine- and coarse-grained budinaged sandstones (500 m) with intercalations and lenses of small-pebbled conglomerates. Locally, the sandstones interchange with argillites which towards the top replace them totally. Within the argillaceous part of the section (200 m) there appear layers of marls and limestones with rich remains of Ammonites: *Juraphyllites stella* (Sow.), *Radsrockceras cf. buvigneri* (d'Orb.), *Paltechioceras boehmi* (Hug), *P. elicatum* Buck., *P. nobile* Truem. & Will., *P. rothpletzi* (Bose), *Epideroceras lorioli* (Hug), *E. steinmanni* (Hug), *E. tchedimicum* Topch. (Topchishvili, 1982).

In the basin of the river of Eastern Gumista analogous sediments contain *Juraphyllites stella* (Sow.), *Echioceras raricostatum* (Ziet.), *Leptechioceras meigeni* (Hug), *L. nodotianum* (d'Orb.). All these forms, except the first two ones, are characteristic of the Upper Sinemurian-Raricostatum Zone. However, relatively large thickness of the described rocks (700 m) gives us the ground to include the Lower Sinemurian substage in this sequence as well.

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FIG. 2.—Correlation of generalized stratigraphic columns of Lower Jurassic deposits of Georgia. 1-shales; 2-fine-grained sandstone and argillites; 3-quartz-arkosic coarse-grained sandstones; 4-conglomerates and gravelstones; 5-marls; 6-limestones; 7-lenses of limestone; 8-lenses of conglomerate; 9-11-volcanic formations: 9-basic composition, 10-intermediate composition, 11-acidic composition; 12-Paleozoic granitoids; 13-levels of ammonite finds.

FIG. 2.—Correlación de las columnas estratigráficas generales de los materiales del Jurásico Inferior de Georgia. 1: Pizarras; 2: Limolitas y areniscas de grano fino; 3: Areniscas cuarcíferas y arcósicas de grano grueso; 4: Conglomerados y gravas; 5: Margas; 6: Calizas en bancos; 7: Calizas en capas lenticulares; 8: Conglomerados en tramos lenticulares; 9-11: Formaciones volcánicas; 9: rocas de composición básica; 10: rocas de composición intermedia; 11: rocas de composición ácida; 12: Granitoides del Paleozoico; 13. Niveles con registro de ammonites.



Eastwards Sinemurian deposits outcrop in Svaneti where they take part in the composition of both Gagra-Djava and Chkhalta-Laila zones. Here they form the limbs of two large en echelon anticlinal structures in the cores of which the pre-Jurassic formations of Dizi series are exposed. Sinemurian deposits (400 m thick) are represented by conglomerates, gravelites, coarse-grained quartz sandstones and shales interchanged with thin-grained sandstones and aleurolites. The presence of lenses of limestones, pyroclastics of quartz albitophyres, charred remnants of trunks, stems and leaves is characteristic of these rocks. With the lower part of this sequence are linked the finds of Early Sinemurian *Arietites* sp. (aff. *bisulcatus* Brug.), *Megarietites* sp., *Primarietites* sp., *Coroniceras* sp., *Vermiceras* sp. aff. *spiratissimum* (Quenst.) (Slavin, Somin & Morgunov, 1962), *Vermiceras spiratissimum* (Quenst.), *V. scylla* (Reyn.), *V. spiratissimum latesella* Erb. (Chikhradze, 1967). The upper part contains Late Sinemurian *Paltechioceras* sp. (Topchishvili, 1987).

The distribution of our paleontological material through the section allowed, to a certain extent, to detail the relationships between Lower Jurassic and underlying Devonian-Triassic rocks of the Dizi series. This problem is known to have given rise to very controversial opinions among investigators. Some of them (Kakhadze, 1947; Gamkrelidze, 1957; Adamia, 1968 and others) supposed that in certain places the basal layers of the Lower Jurassic lie transgressively on different horizons of the Dizi series, but locally the latter quite conformably, without any gap, pass into Lower Jurassic. The works by Slavin, Somin & Morgunov (1962), Belov & Somin (1964) showed, on the basis of all available materials, that in late Triassic or Early Jurassic Svaneti underwent absolute uplift and Jurassic formations everywhere occur transgressively upon the different horizons of the Devonian-Triassic.

The existence of the hiatus between the Devonian-Triassic Dizi series and Lower Jurassic has been confirmed by our faunistical finds (Topchishvili, 1987), such as *Arnioceras geometricoides* Erb., *A. cf. miserabile* (Quenst.), discovered in the vicinity of the ridge of Bakild at 60 m up from the sole of Sinemurian deposits. These fossils represent guide forms of the middle part of the Lower Sinemurian - the zone of *Semicostatum*. Underlying beds of 60 m thick correspond, most likely, by their stratigraphic position to the lowermost zone of the Sinemurian stage - the Bucklandi Zone. Apparently, there is no ground here to assume the presence of the Hettangian stage in the base of the Jurassic section. The same situation is observed in the valley of the Inguri river where over the deposits of the Dizi series containing Late Triassic spores and pollen occur layers with Sinemurian Bivalves. Consequently, even when Lower Jurassic immediately lies on the Upper Triassic, the absence, probably everywhere, of the Hettangian stage evidences of the stratigraphic gap between them.

To the north-east, in the Kakhetian part of the Kazbegi-Lagodekhi zone, at the base of the Lower Jurassic section there is a sequence (700 m) composed of thin- to coarse-grained sandstones, gravelstones, conglomerates interchanging with shales and andesite-dacitic and albitophyric pyroclastics. Lenses of li-

mestones are also encountered in which *Arietites bisulcatus* (Brug.), *Coroniceras* sp. ind., *Vermiceras* aff. *spiratissimum* (Quenst.), *Arnioceras* sp., *Euasateroceras* sp. and *Paltechioceras* cf. *elicitum* Buck. are found. These ammonites allowing to admit the Sinemurian age of containing rocks were collected from the uppermost part (200 m) of the sequence. Its lower part must also correspond to Sinemurian and, possibly, the top of Hettangian stage.

On the Georgian block Sinemurian deposits extend along the south-western periphery of the Dzirula massif where they transgressively overlap the volcano-continental sequence of the so-called «lower tuffites» (from a few m up to 700 m thick) and crystalline rocks of the Paleozoic basement.

The question of the age of the «lower tuffites» remains still problematic. We confine their age by the limits of the Hettangian stage. This assumption is confirmed, on one hand, by the stratigraphic position of the suite (it underlies the deposits with Early Jurassic Ammonites) and on the other hand, by finds in its basal layers the remnants of fossil flora whose lower age range does not exceed Jurassic limits (Svanidze, 1971).

The greater part of the Sinemurian here is represented by fine-grained micaceous sandstones (up to 100 m) with flora remnants which almost everywhere are underlain by quartz-arkosic coarse-grained sandstones (25 m) with lenses of middle-pebbled conglomerates in the base. The micaceous sandstones contain *Arnioceras ceratitoides mexicanum* Erb., *Vermiceras* sp. and *Microderoceras* sp.

Rich complex of ammonite remains substantiates the Sinemurian age of deposits in the Locki-Karabakh zone where they, in the form of a narrow nearly uninterrupted band, enclose the Locki massif. Here, the Sinemurian is represented by a rather uniform sequence (up to 3000 m) of fine-grained micaceous sandstones overlying conformably Hettangian coarse-grained quartz sandstones with conglomerates in the base.

One of the sections of Sinemurian deposits which is most thoroughly faunistically characterized, is located in the basin of the river of Gulmagometchai (western periphery of the massif). This section is composed of: 1. dark-grey fine-grained micaceous sandstones and sandy aleurolites with lenses of ferruginous calcareous rocks and numerous remains of flora detritus (160 m). In sandstones were found ammonites: *Vermiceras ultraspiratum* Fuc., *V. spiratissimum* (Quenst.), *V. francisci* Fuc., *V. solarioides* Cos., *V. cf. scylla* (Reyn.), *Metophioceras cordieri* (Can.), *Arnioceras kridioides* (Hyatt) and others (Topchishvili, 1989); 2. grey fine-grained sandstones and aleurolites (60 m) with *Arnioceras ceratitoides* (Quenst.), *A. harpoides* Erb., *A. italicum* Fuc. (Topchishvili, 1989). These ammonites indicate here the presence of two Sinemurian zones- Bucklandi and Semicostatum.

In the uppermost layers of sandstones the presence of *Microderoceras* cf. *birchi* (Sow.) was determined (Panov, 1978).

In the central part of the northern periphery of the Locki massif, at the vicinity of Ortaposta, the lower layers composed of micaceous-feldspar-quartz

sandstones contain the following Early Sinemurian forms: *Epammonites* cf. *latisulcata* (Quenst.), *Vermiceras* aff. *supraspiratum* (Wahn.) and *Metophioceras cordieri bifurcata* Nout. More upper horizons contain *Microderoceras* cf. *birchi* (Sow.), *M.* sp. (ex gr. aff. *birchi* Sow.) and Late Sinemurian *Oxyntoceras* cf. *doris* (Reyn.). Here the presence of the uppermost part of the Sinemurian stage is confirmed by finds of *Echioceras raricostatum* (Ziet.) and *Epideroceras steinmanni* (Hug) (Zesashvili, 1967).

In the western periphery of the massif, along the river of Moshevani and in the lower reaches of its right tributary at the different levels of the 120 m-thick sequence of micaceous sandstones were found early Sinemurian *Vermiceras* cf. *spiratissimum* (Quenst.), *Microderoceras* cf. *birchi* (Sow.) and late Sinemurian *Paltechioceras elicatum* Buck., *P. dignatum* Truem. & Will., *P. rothpletzi* (Bose), *Epideroceras steinmanni* (Hug) and *E. lorioli* (Hug) (Topchishvili, 1989). The last ammonite association corresponds to the uppermost Sinemurian-Raricostatum Zone.

## PLIENSBACHIAN DEPOSITS

Pliensbachian deposits are spread more widely than underlying ones and, as a rule, they are not rich in ammonites that, in most cases, prevents their division into substages. This is especially true of the Fold system of the Greater Caucasus. The only exception is the Abkhazian part of the Gagra-Djava zone. Here, the lower substage (400 m) consists of argillites, usually calcareous, with interlayers of the limestones and marls. Considerable role in its formation play volcanogenic rocks of spilite-quartz-keratophyric composition and accompanying sills. The lower part of this sequence contains Early Pliensbachian *Platypheuroceras variscoi* Par., *Uptonia angustata* (Quenst.), *Tropidoceras masseanum* (d'Orb.) (Topchishvili, 1982) and in the upper part was found *Arietoceras* cf. *algovianum* (Opp.) indicating the late Pliensbachian age of host rocks. The lower Ammonite complex is included by us in the regional Masseanum Zone (Table 1).

Overlying rocks (500-550 m thick) are mainly represented by argillites, usually calcareous, with interlayers of aleurolites and thin-grained sandstones. Considerable part of these deposits contains *Amaltheus margaritatus* (Montf.) and *A. stokesi* (Sow.).

Somewhat northwards, in the eastern part of the Chkhaltal-Laila zone, the Pliensbachian stage contains, together with terrigenous rocks, common limestone lenses, sometimes of rather considerable dimensions. The length of some of them exceeds 1 km. Here, only Upper Pliensbachian is characterized by ammonite fossils. The presence of this substage is confirmed by finds in shales of Late Pliensbachian ammonites: *Phylloceras hebertinum* (Reyn.), *P. zetes* (Monest.), *Amaltheus margaritatus* Montf.

Westwards, in the upper reaches of the Atsgara river and in the basin of the



TABLE 1.—Ammonite zonal subdivision of the Lower Jurassic deposits of Georgia.

TABLA 1.—Subdivisión zonal de ammonoideos en los materiales del Jurásico Inferior de Georgia.

General stratigraphic scale (Decision..., 1978)				REGIONAL BIOSTRATIGRAPHIC UNITS AND TYPICAL AMMONITE COMPLEXES			
System	Section	Stage	Substage	ZONE			
JURASSIC	LOWER	Toarcian	Upper	Dumortiera levesquiei	Dumortiera levesquiei	<i>Dumortiera pseudoradiosa</i> (Bran.), <i>D. radiosa</i> (Seeb.), <i>D. brancoi</i> Ben., <i>D. axigua</i> Buck., <i>D. bleicheri</i> Ben., <i>D. moorai</i> (Lyc.) etc.	
				Grammoceras thouarsense	Grammoceras thouarsense	<i>Grammoceras thouarsense</i> (d'Orb.), <i>G. striatum</i> (Sow.), <i>G. cf. quadratum</i> (Haug), <i>Pseudogrammoceras fallaciosum</i> (Bayle) etc.	
				Haugia variabilis	Peronoceras	<i>Catacoeloceras raquinianum</i> (d'Orb.), <i>Peronoceras subarmatum</i> (Y. et B.), <i>P. fibulatum</i> (Sow.), <i>Hildoceras bifrons</i> (Brug.), <i>H. cf. sublevinsoni</i> Fuc., <i>Phymatoceras cf. narbonneense</i> Buck., <i>P. cf. tirolense</i> (Hauer), <i>P. comense evoluta</i> (Renz), <i>Haugia cf. variabilis</i> (d'Orb.) etc.	
			Lower	Hildoceras bifrons	subarmatum		
				Harpoceras faicifer	Harpoceras faicifer-Hildaites serpentinus	<i>Harpoceras faicifer</i> (Sow.), <i>H. mulgravi</i> (Y. et B.), <i>Hildaites serpentinus</i> (Rein.)	
				Doctlioceras tenuicostatum			
		Pliensbachian	Upper	Pleuroceras spinatum	Pleuroceras spinatum	<i>Pleuroceras spinatum</i> (Brug.), <i>P. coronatum</i> (Quenst.)	
				Amaltheus margaritatus	Amaltheus	<i>Amaltheus margaritatus</i> Montf., <i>A. subnodosus</i> (Y. et B.), <i>A. laevigatus</i> How., <i>A. stokesi</i> (Sow.), <i>Fuciniceras issell</i> (Fuc.), <i>F. boschense</i> (Rein.), <i>Arietoceras bertrandi</i> (Kill.), <i>A. cf. algovianum</i> (Opp.) etc.	
				Amaltheus stokesi	subnodosus		
			Lower	Productylioceras davoei		<i>Androgynoceras cf. latecostatum</i> (Sow.)	
				Tragophylloceras ibex	Tropidoceras	<i>Platipleuroceras variscoi</i> Par., <i>Uptonia angustata</i> (Quenst.), <i>Tropidoceras masseanum</i> (d'Orb.), <i>T. stahli</i> (Opp.), <i>Polymorphites</i> sp., <i>Acanthopleuroceras</i> sp.	
				Uptonia jamesoni	masseanum		
		Sinemurian	Upper	Echioceras raricostatum	Echioceras raricostatum	<i>Echioceras raricostatum</i> (Ziet.), <i>Epideroceras steinhanni</i> (Hug), <i>Paltarcoceras boehmi</i> (Hug), <i>P. elichum</i> Buck., <i>P. studeri</i> (Hug) etc.	
				Oxynoticeras Oxynotum		<i>Oxynoticeras cf. doris</i> (Rein.)	
				Asteroceras obtusum			
			Lower	Caenisites turneri	Microderoceras cf. birchi	<i>Microderoceras cf. birchi</i> (Sow.)	
				Arnioceras semicostatum	Arnioceras semicostatum	<i>Arnioceras geometricoides</i> Erb., <i>A. cf. miserabile</i> (Quenst.), <i>A. speciosum</i> Fuc., <i>A. harpokides</i> Erb., <i>A. caralitoides</i> (Quenst.) etc.	
				Arietites bucklandi	Arietites bucklandi	<i>Arietites bisulcatus</i> (Brug.), <i>Epanormites cf. bisulcatus</i> (Quenst.), <i>Verniceras spiratissimum</i> (Quenst.), <i>V. francisci</i> Fuc., <i>V. ultraspiratum</i> Fuc. etc.	
		HETTANGIAN					

Bzibi river the amount of calcareous material considerably decreases and the Pliensbachian stage consists mainly of shales (600 m) with *Amaltheus margaritatus* Montf., *Paltarcoceras argutus* Buck. in the upper part of the sequence. Its lower part is quite conventionally attributed to the Lower Pliensbachian.

The described terrigene-carbonate deposits conformably pass into pyroclastics of andesite-basaltic composition with thin layers of shales of total

thickness up to 200 m. In the shales on the right bank of the Atsgara river we discovered *Amaltheus margaritatus* Montf., *A. stokesi* (Sow.), *A. laevigatus* How., *A. cf. subnodosus* (Y. & B.) (Topchishvili & Lobja-Nidze, 1980).

On the northern margin of the Chkhalta-Laila zone (within the confines of Abkhazia) synchronous deposits are composed of quartz-keratophyric lavas, shales and sandstones with *Amaltheus margaritatus* Montf. (Lomize, 1969) and also of pyroclastics of spilitic porphyrites. Their thickness varies from 400 to 700 m.

Overlying deposits are represented by a uniform sequence (900 m) of shales with subordinate beds of aleurolites with associated lavas of globular spilitic porphyrites. The greater part of this sequence is characterized by Late Pliensbachian *Amaltheus margaritatus* Montf. and *A. cf. subnodosus* (Y. & B.).

To the southeast Pliensbachian deposits take part in the formation of the Upper Svaneti and Lower Svaneti anticlinal structures. Here they are represented by a thick sequence (1200 m) of monotonous shales with very rare sandstone beds. The age of the upper part of the sequence is established by finds of *Amaltheus margaritatus* Montf. and *A. stokesi* (Sow.).

Joint finds on the same level of representatives of genus *Amaltheus* allows us to recognize the regional Subnodosus Zone embracing two standard zones-Stokesi and Margaritatus (Table 1).

The northernmost outcrops of these deposits are located in the zone of the Main Range of the Greater Caucasus. Here, on the territory of Abkhazia and Svaneti they have been preserved in the form of small outliers. In the zone of the Main Range the eroded surface of pre-Jurassic formations is transgressively overlain by fine-pebbled conglomerates and coarse-grained arkosic sandstones (up to 200 m) which upward are replaced by fine-grained sandstones, aleurolites and shales (400 m) with *Arietoceras algovianum* Opp. and *Amaltheus margaritatus* Montf. (Khutsishvili, 1972). The thickness of Pliensbachian deposits considerably increases to the east, in the Fore Range (Khevsureti) where it exceeds 2000 m. They consist of black shales with striated varieties and rare intercalation of sandstones. The age of these deposits was substantiated by late Pliensbachian *Arietoceras cf. bertrandi* (Kil.), *A. cf. algovianum* (Opp.) and by their stratigraphic position in the section.

The late Pliensbachian Ammonites *Amaltheus subnodosus* (Y. & B.) and *A. striatus* How. have been mentioned (Khimshiashvili, 1974) in analogous deposits developed in the Kakhetian part of the Kazbegi-Lagodekhi zone.

Within the Pliensbachian stage in the southern periphery of the Dzirula massif essential role play carbonate rocks - marls, marly limestones and red organogenic limestones up to 40 m thick. From the lower horizons were collected *Acanthopleuroceras* sp., *Tropidoceras stahli* (Opp.), *Polymorphites* sp. and from the upper ones - *Phylloceras bonarelli* Bett., *P. zetes* (Monest.), *P. hebertinum* (Reyn.), *Calliphylloceras emeryi* (Bett), *Amaltheus margaritatus* Montf., *A. subnodosus* (Y. & B.), *Pleuroceras spinatum* (Brug.), *P. coronatum* (Quenst.), *Fucinoceras isseli* (Fuc.), *Arietoceras bertrandi* (Fuc.).

In the north-eastern periphery of the Dzirula massif the limestones are replaced by argillites and marly clays (up to 125 m) with *Amaltheus margaritatus* Montf.

Pliensbachian deposits of the Locki massif can be subdivided into two parts: the lower part - micaceous fine-grained sandstones (90 m) with *Tropidoceras* cf. *masseanum* (d'Orb.), and the upper one - argillites intercalated with sandstones and aleurolites with relics of *Amaltheus margaritatus* Montf.

## TOARCIAN DEPOSITS

Deposits of this stage are, as a rule, more abundant in fossil remains than those of Pliensbachian. In the Fold system zone of the Greater Caucasus these sediments are characterized by a considerable increase of sandstone layers.

In the north-eastern part of the Greater Caucasus, in the Fore Range zone (the territory of Tusheti) the Toarcian stage is subdivided into two substages. The lower substage (700 m) consists of aleurolitic shales with sandstone intercalations and various concretions of clayed siderite. From the ammonite fauna collected here we determined *Catacoeloceras* sp., *Dactylioceras* sp., *Harpoceras falcifer* (Sow.), *H. mulgravium* (Y. & B.), *Hildaites serpentinus* (Rein.), *Orthildaites orthus* Buck. and *Hildoceras bifrons* Brug. The upper Toarcian (900 m) is composed of fine-, middle- and coarse-grained sandstones alternating with shales which locally contain small lenses of limestones and Ammonite associations: *Haugia* cf. *variabilis* (d'Orb.), *Harpoceras* cf. *subplanatum* (Opp.), *Polyplectus discoides* (Ziet.), *Grammoceras thouarsense* (d'Orb.), *G. striatulum* (Sow.), *G. penestriatulum* Buck., *G.* cf. *quadratum* (Haug), *G. subquadratum* Buck., *Pseudogrammoceras* cf. *fallaciosum* (Bayle), *P. cotteswoldia* Buck., *P. thusheticum* Topch. (Topchishvili, 1990), *Pleydellia* cf. *aalensis* (Ziet.) and *Hammatoceras* cf. *insigne* (Schub.).

The similar composition Toarcian deposits have farther west, in Khevsureti. Here they are made up of an irregular alternation of fine-grained sandstones and shales with clayed sideritic concretions. The age has been established by finds of *Dactylioceras* sp., *Denckmannia* sp., *Haugia* sp., *Grammoceras thouarsense* (d'Orb.), *Dumortieria* cf. *bleicheri* Ben., *D. gundershofensis* (Haug), *D. brancoi* Ben., *D. radiosa* (Seeb.), *D. pseudoradiosa* Bran., *D. cf. tabulata* Buck., *D. moorei* (Lyc.), *D. mactra* (Dum.) and *Pleydellia subcompta* (Bran.).

On the Southern slope, in the eastern part of the Kazbegi-Lagodekhi zone (Mountainous Kacheti) Toarcian is mainly represented by thick - bedded, in places massive, sandstones with interlayers and beds of shales. The sandstones are locally calcareous with faintly expressed flysch figures. *Peronoceras* sp. and *Catullocceras* sp. found respectively at the base and in the top of a 600 m thick sequence give possibility of assuming here both the lower and upper Toarcian. To the north-west, in the area between the rivers of Didkhevi and Iori, the role of shales gradually increases and here they prevail over sandsto-

nes. At the same time, the thickness of the sequence also increases reaching here 800 m. Only late Toarcian ammonites have been stated in these rocks: *Grammoceras thouarsense* (d'Orb.), *Pseudogrammoceras* cf. *saemanni* (Dum.), *Dumortieria bleicheri* Ben., *D. gundershofensis* (Haug), *D. moorei* (Lyc.), *D. subundulata* (Bran.), *D. tabulata* Buck., *D. exigua* Buck., *D. cf. costula* (Rein.), *Pleydellia subcompta* (Bran.) and *P. crinita* (Buck.).

Early Toarcian Ammonites appear in the western part of this zone, in Northern Svaneti. These are *Maconiceras* sp., *Hildoceras* sp. and *H. cf. sublevisoni* Fuc. found by us in the 600 m thick sequence of shales and sandstones. The uppermost part of this sequence (1100 m) is characterized by increased amount of sandstones, locally calcareous. Almost the whole section contains fossil remnants most of which are represented by guide forms undoubtedly indicating the presence of the upper Toarcian-Thouarsense and Levesquei Zones. To confirm this assumption the following list of fossils is given below: *Grammoceras* cf. *striatulum* (Sow.), *Pseudogrammoceras* cf. *saemanni* (Dum.), *P. subregale* Pin., *P. fallaciosum* (Bayle), *P. cf. muelleri* (Denck.) (Topchishvili & Lobjanidze, 1977), *Pleydellia aalensis* (Ziet.), *Dumortieria exigua* Buck., *D. mactra* (Dum.) and *D. bleicheri* Ben.

In the Chkhalta-Laila zone in Abkhazia the Toarcian stage includes an outcrop of shales showing a thin and rather consistent sequence (400 m) of striated sandy-aleurolitic shales with interlayers of aleurolites and fine-grained sandstones. The amount of the latter is very changeable - sometimes they almost disappear, at other times they alternate with shales. This sequence also contains interlayers of tuffs and tuffites of spilitic and quartz-keratophyric composition. Within the shales has been found *Harpoceras* cf. *falcifer* (Sow.) and the striated varieties contain *Calliphylloceras* cf. *aveyronense* (Men.), *C. ex. gr. supraliasicum* (Pomp.), *Harpoceras subplanatum* (Opp.), *Grammoceras* cf. *thouarsense* (d'Orb.) and *Denckmannia* sp.

In the southernmost part of the Southern slope of the Greater Caucasus Toarcian deposits are developed in the Gagra-Djava zone. Lithologically they are composed of an alternation of sandstones and argillites with predominance of the former. Argillites usually contain remnants of charred detritus. The thickness of sandstone beds ranges from a few cm to tens of m. The surfaces of bedding are characterized by the presence of flysch figures. Sandstones in places turn into microconglomerates and breccia beds composed of unrounded fragments of shales. It is a rather thick (800-900 m) flyschoid sequence which at its different levels contains *Harpoceras falcifer* (Sow.), *Hildaites* aff. *serpentinus* (Rein.), *Grammoceras penestriatum* Buck., *G. cf. thouarsense* (d'Orb.), *Dumortieria mactra* (Dum.), *Pleydellia lotharingica* (Bran.) and *P. crinita* (Buck.).

The Toarcian stage in the Dzirula massif is identified within the 30 m thick sequence of red organogenic limestones. Its presence is substantiated by finds of the following ammonites: *Harpoceras falcifer* (Sow.), *Catacoeloceras raquinianum* (d'Orb.), *Peronoceras subarmatum* (Y. & B.), *Hildoceras bifrons* (Brug.), *Phymatoceras comense evoluta* (Renz.), *Prachaploceras zwieselei*

Monest., *Grammoceras thouarsense* (d'Orb.), *G. quadratum* (Haug), *Pseudogrammoceras saemanni* (Dum.), *Pleydellia aalensis* (Ziet.), *Dumortieria levesquei* (d'Orb.), *D. gundershofensis* Buck., *Hammatoceras speciosum* Jan.

Somewhat poorer Toarcian deposits are characterized by fossils in the north-eastern periphery of the Dzirula massif. Here, in the argillitic strata (90 m) were found only *Grammoceras thouarsense* (d'Orb.) and *Pseudolioceras* cf. *lythense* (Y. et B.).

In the Locki massif Toarcian embraces a part of the flyschoid sequence with *Peronoceras fibulatum* (Sow.), *Harpoceras* cf. *falcifer* (Sow.), *Grammoceras* cf. *penestriatum* Buck., *Hildoceras lateplicata* Nout., *Phymatoceras* cf. *narbonense* (Buck.), *Pseudogrammoceras* cf. *fallaciosum* (Bayle), *Dumortieria striatulocosta* (Quenst.).

## CONCLUSIONS

Ammonites in Georgia are spread nearly through the whole area of the distribution of Lower Jurassic deposits. Considerable bulk of species come from Sinemurian, upper Pliensbachian and Toarcian deposits. In the lower Pliensbachian the amount of species notably decreases. In general, here ammonites are distinguished by great variety of composition. The presence of many archistatigraphic genera and species among which index-ammonites are encountered as well, allows to specify in Georgia some zones of Western Europe (Table 1) and, in some cases, regional stratigraphic subdivisions.

The oldest zone established within the Lower Jurassic is the lowermost Sinemurian - Bucklandi Zone. It is specified by the rich complex of ammonites belonging to the following species: *Arietites*, *Vermiceras*, *Metophioceras* and *Epanmonites*.

The strata with fossils of the Bucklandi Zone are overlain by deposits containing *Arnioceras ceratitoides* (Quenst.), *A. harpoides* Erb., *A. italicum* Fuc., etc., permitting to establish here the second standard zone of Sinemurian: - Semicostatum Zone.

The uppermost zone of the Lower Sinemurian - Turneri Zone can be correlated with the strata containing *Microderoceras* cf. *birchi* (Sow.) distinguished by the finds of Ammonites of the same name.

Especially reliably is specified by ammonites the roof of Sinemurian which is represented by Raricostatum Zone. It is presented by species of the following genera: *Paltechioceras*, *Leptechioceras*, *Echioceras* and *Epideroceras*.

Upwards the Late Sinemurian ammonite association is replaced by another one which forms the regional Masseanum Zone identified by us. It is composed by *Uptonia angustata* (Quenst.), *Tropidoceras masseanum* (d'Orb.) *Platypleuroceras variscoi* Par. and some other forms.

Very numerous are finds of ammonites in the upper part of the Pliensbachian stage. Especially frequent among them are *Amaltheus margaritatus*

Montf. and *A. subnodosus* (Y. & B.) which in most sections are found along with the index-species of the lower zone of upper Pliensbachian - *Amaltheus stokesi* (Sow.). Therefore, it is only possible to single out the Subnodosus regional zone.

Within the lower Toarcian substage, on the basis of individual finds of *Harpoceras* and *Hildoceras* species, layers with *Harpoceras falcifer*-*Hildoceras serpentinus* have been singled out.

The top of lower Toarcian and the base of upper Toarcian are considered as the Subarmatum regional zone which through its range corresponds to two adjacent Bifrons and Variabilis standard zones. Here, within this zonal association representatives of *Catacoeloceras*, *Peronoceras*, *Hildoceras*, *Phymatoceras* and *Praehaploceras* genera are present.

The overlying Thouarsense Zone is distinguished by the rich and diverse association of ammonites. It contains *Polyplectus discoides* (Ziet.), *Grammoceras thouarsense* (d'Orb.), *G. quadratum* (Haug), *Pseudogrammoceras fallaciosum* (Bayle), etc.

Finally, the Levesquei Zone completing the Toarcian stage is substantiated by numerous representatives of the genus *Dumortieria*.

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