# POSTER.

1. **Correlation of the Late Quaternary sediments of the Eastern Mediterranean and Ponto-Caspian basins**

## Sorokin, V1, Yanina T2

### 119991, Moscow, Leninsky Gory, 1, Moscow State University

### [*1sorokin@geol.msu.ru*](mailto:1sorokin@geol.msu.ru)*, 2didacna@mail.ru*

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1. **Introduction.** For modern deep-sea basins with restricted connection to the World ocean (Black, Caspian, Marmara, Aegean and Mediterranean seas), there is the problem of stratigraphic correlation as shallow-water (shelf) and deep-water sections within seas and between them. It consists in the use of various paleontological groups of residues for sediments of shelf and deep-sea basins (mollusks, foraminifera, coccolithophorids, diatoms, pollen and spores, etc.) and lithostratigraphy. However, depending on the degree of isolation of the seas, which determines the salinity of water, the qualitative composition of fauna and flora in them are radically different. Reliable correlation of the sections in these cases is based on very few definitions of absolute age.
2. There are different points of view on the age of the stratigraphic units of the Upper Quaternary deposits for the Mediterranean Sea, for the Black Sea and especially for the Caspian Sea. Depending on the accepted points of view, a particular correlation of sections and their paleogeography interpretation are carried out. The reliable determination of radioisotope age of deposits has a crucial importance, allowing us to synchronize age boundaries, which are selected by biostratigraphic and lithological methods.
3. **Stratigraphy.** Upper Quaternary deposits are divided on the basis of alteration of complexes of residues, reflecting climatic variations. The applicability of different paleontological remains for the different facial conditions within and between various seas is distinguished, that is associated with substantial changes in the salinity of basin waters. Marking lithological horizons (sapropel, tephra, calcareous and diatomaceous layers) use for correlation in addition.
4. In accordance with the purpose of the international project IGCP 610 we conducted a comparative stratigraphic analysis of the Upper Quaternary sediments of the above-mentioned intra-continental basins. The results of processing many tens of cores and boreholes from shelves, continental slopes and deep-water basins of the Eastern Mediterranean, Black Sea and North and Middle Caspian Sea are presented in our work.
5. ***The Eastern Mediterranean*.** We have identified the Riss-Wurm, Wurm and Holocene horizons in sections of the Upper Quaternary deposits. Among the planktonic foraminifera in them alternate "warm" (with the dominance of Globigerinoides ruber, G. succulifer, G. rubescens, Hastigerina aequilateralis, Orbulina universa, Globoquadrina dutertrei) and the "cold-water" (Globigerina pachyderma, G. quinqueloba, G. bulloides, Globorotalia scitula) complexes. The сomposition of benthic foraminifera is presented by two complexes too, according to "cold-water" and "warm-water" complexes of planktonic foraminifera. The "cold-water" one includes s the following types: Bolivina dilitata, B. albatrossi, Cassidulina carinata, Hofkeriana alata, Bulimina marginata, B. costata, B. gibba, B. spinifera, Brizalina catanensis, anguloza Trifarina, Uvigerina auberiana, Gavelinopsis sp. Conveza Epistominella rugosa, Cibicidoides floridanus, Miliolinella circularis, Hyalinea baltica; and the "warm" complex - Uvigerina mediterranea, Cassidulina crassa, C. oblonga, Bolivina pseudoplicata, Globobulimina pseudospinescens, Bulimina exilis, Nonion barleeanum, Hoeglundina elegans, Gyroidina umbonata, G. neosoldanii, G. altiformis, Melonis formosum. In addition to species diversity of benthic foraminifera in sediments, differences were marked in their quantity. So "warm-water" complex is characterized by a minimum, and "cold-water" maximum number of copies. The composition of diatoms revealed fluctuations in the ratio of marine, brackish and freshwater species belonging to the littoral, neretic, and oceanic ecological groups. "Warm" and "cold-water" forms are among them. In the composition of pollen spectra in the sedimentary section there is a change of complexes with high content of arboreal pollen, indicating a moisture climate, and with absolute dominance of herbaceous pollen, indicating the arid climate. Marking layers of sapropel and tephra are highlighted in sediments.
6. Light gray calcareous silts *underlying Riss-Wurm horizon* on the continental slope of the Gulf of Sirte contains 65% cold-water planktonic foraminifera, among which is noted the maximum number of Globigerina quinqueloba (up to 40%) and G. bulloides (15%). Among benthic foraminifera, characterized by the highest diversity and quantity Gavelinopsis sp. and Bolivina albatrossi are dominated. Pollen of herbs- xerophytes (over 70%) dominate in the composition of pollen spectrum, among which is defined Ephedra, Chenopodiaceae, and Artemisia are define. Arboreal pollen is represented by mostly pine.
7. *The Riss-Wurm* transgression horizon is presented in Gulf of Sirte by green sapropel and in the Levantine basin by light gray, silt-clay foraminiferal-coccolithus ooze with three sapropel layers (S3-S5). Warm-water species of planktonic foraminifera (60-80%) dominate, and in the sapropels notes the maximum number of Globigerinoides sacculifer, G. rubescens, G. ruber, Glo-boquadrina dutertrei are marked. Benthic foraminifers are absent or are contained in non-significant amount (not exceeding 50 copies). In spore-pollen complexes high content of arboreal pollen (20-80%) is noted, the main role in which plays pine. However, in the sapropel layers is observed a great number of species the pollen of broad-leaved trees: oak, ash, walnut, hornbeam, elm, beech, chestnut, wine, pistachio, magnolia, and palm.
8. In *Wurm* horizon, which formed during regressive phases separated by transgression, variations in the contents warm and cold-water planktonic foraminifera were marked. So, in the Lower Wurm the number of warm-water species is reduced to 5-47% compared with Riss-Wurm. In the sediments of the Middle Wurm it increases to 60-75%. In ooze of the Upper Wurm again drops to 10-30%. In the latter case, it is noted the maximum number of cold-water species (50-70%). Among benthic foraminifera, representatives of the "cold" complex are the most abundant. Planktonic neretic species, inhebited in the coastal brackish areas are dominated in diatom composition. The brackish-water species reach here maximum. Coscinodiscus marginatus prevails among marine species. In the Late Wurm the number and species diversity of diatoms are reduced. Iintertidal species, such as Paralia sulcata, Rhaphoneis surirella etc. are the most representative here. In the lower part of the horizon value of the marine forms somewhat increased from the previous interval, but then it falls again, reaching its minimum. Apparently, this was influenced of Late Wurm glaciation, which led to the fall of sea level. Wurm sediments contains little pollen and spores, and often they do not exist. At the bottom of Wurm dominance of pollen of herb-xerophytes (60-80%) is observed; in the middle layer the value of arboreal pollen up to 30-60% increases, mostly pine. In the upper layer herbaceous pollen dominates, and in group of arboreal pollen pine is most abundant with a small admixture of pollen of deciduous trees.
9. The Wurm sediments is presented, usually by calcareous silt-pelitic and politic muds in the Adriatic and Ionian seas and in the northern part of the Levant Sea. Along the coast of Africa siltstone-pelitic and calcareous silts are common containing clay-limestone chemogenic concretions. On the Nile slope a strong variability in sediment composition appears from pure clay type to calcareous silts. A characteristic feature of the structure of the sections is the presence of interbedded coarse-grained sandy-silt and even gravel material. In conjunction with the facies variability in the Nile cone area, these features indicate on the activation at this time slope processes.
10. In eight columns of the Middle Wurm sediments the interlayer of ash lies in the area spread up to the coast of Africa. By chemical composition it is characterized by high content of alkalis, with K2O dominates over Na2O. This interlayer ash is well correlated between the cores and identified with ash interlayer Y-5, which was deposited about 35 thousand years ago.
11. Transgressive *Holocene* horizon is composed by calcareous sediments containing an interlayer of sapropel S1 and ash layers. Warm-water species (45-90%) is dominated among the planktonic foraminifera in the sediments. Benthic foraminifers hase a few number and also are presented by "warm-water" complex. Pollen and spores are presented in significant quantities only in the sapropel. The arboreal pollen (50-80%) dominates here, and pollen of deciduous aqueous species reachs up to 40% of its population with a rich species diversity. In the sapropel layer, there is a sharp jump in species diversity of diatoms mainly of benthic forms. Most of them (genera Grammatophora, Diploneis, Lyrella) first appear in this interval. However, neretic species (Thalassiosira deeipiens, Coscinodiscus marginatus, Chaetoceros sp.) predominate and a more prominent role relative to underlying sedimens play the oceanic diatoms (Thalassiosira oestrupii, and Coscinodiscus asteromphalus), which is absent below. In general, marine diatoms is dominated here. In the overlying sediments (middle-upper Holocene) the brackish-water species are completely absent, and among marine species oceanic forms (Thalassiosira excentrica Th. oestrupii, and Coscinodiscus madiatus) are the most prevalent.
12. ***The Black Sea***. In the sections of the Upper Quaternary sediments from the bottom up we divided the following horizons: Karangatian, Postkarangatian, Sourozh, Novoeuxinian, Oldchernomorian, Novochernomorian. On the shelf they are determined by change of complexes of Pelecypoda, reflecting the changing freshwater and marine conditions.
13. *Karangatian* transgressive sediments contain the most stenogaline and a thermophilic mollusk shells (Cardium tuberculatum), planktonic foraminifera, etc. According A.Arslanov their ages defined in the range 90-129 thousand years ago (230Th).
14. *Postkarangatian* regressive sediment opened on the Bulgarian shelf. They contain shells of Dreissena and Monodacna with redeposited marine karangatian species.
15. Discussing *Sourozh* transgressive strata defined on the North-West shelf under a mixed brackish and marine fauna.
16. *Novoeuxinian* regressive-transgressive sediments conclude weakly brackish-water mollusks of the genera Dreissena and Monodacna. Their age is defined in the range from >30 to ⁓7 thousand 14C years BP.
17. *Oldchernomorian* transgressive sediments are distinguished by the predominance of shells Mytilus galloprovincialis. Their radiocarbon age ranges from about 7-8 thousand years BP to 3-4 thousand years BP.
18. Crowning the sections *Novochernomorian* transgressive sediments contain characteristic species Modiola phaseolina.
19. In the deep-sea depression Karangatian sediments is represented by two types: sapropel and coccolith ooze. They contain a marine complex of diatoms and ocean coccolithophorida Gephyrocapsa caribbeanica. Between Karangatian and Oldchernomorian deposits in deep-sea boreholes powerful strata of clayey silts was discovered, in the upper part of which there are Novoeuxinian layers revealed also by numerous cores. They contain a complex of freshwater diatoms, predominantly Stephanodiscus astraea species, and include diatoms and chemogenic limestone interlayers. AMS 14C age revealed sediments varies from >25 to about 8 thousand years BP. Oldchernomorian deposits are of the Black sea sapropel, which contains a marine complex of diatoms and coccolithophorida species Braarudosphaera bigelowii. In its lower part there are many thin layers of aragonite mud. AMS 14C age of the sapropel lies in the range of 3-7 thousand years BP. Novochernomorian sediments are composed of thinly bedded, clayey-calcareous silts with Emiliania huxleyi.
20. ***The Caspian Sea.*** In the thickness of the Upper Quaternary deposits exposed of wells and cores we divided Hyrcanian, Atelian, Khvalynian, Enotaevian, Mangyshlakian and Novocaspian horizons. The most complete sections are present on the shelf of the Northern Caspian, where their dismemberment carried out on the fauna of mollusks, the characteristics of the structure and distribution identified according to seismoacoustic profiling.
21. *Girkanian* transgressive horizon is represented by layered sediments mostly clay mud with inclusion of the characteristic species of mollusks: Didacna subcatillus, D. cristata. D. parallella. Their AMS 14C age greater than 60 years, and U/Th230 is 100-122 thousand years.
22. Regressive *Atelian* horizon is represented by red-coloured subaeral sediments, containing a rare freshwater molluscs: Unio sp. Limnea stagnalis, Dreissena polymorpha polymorpha, Aninus eichwaldi, Valvata piscinalis, Theodoxus pallasi. They fill erosional incisions produced in the Gyrcanian layers. Deposits contain large amounts of plant residues of freshwater bodies. The calibrated 14C age of the upper layers is 40-44 thousand years.
23. Transgressive the *Khvalynian* horizon is represented by two sub-horizons, separated *Enotaevian* regressive layers. The Lower Khvalynian deposits at the base are composed of clay and sandy varieties with a large number of shells, which on seismoacoustic records serve as a regional reflector. Above the layered clay strata lies with interlayers of shells. In its composition we have defined D. ebersini, D. protracta, D. zhukovi, D. parallella, D. subcatillus, D. cristata, D. praetrigonoides. AMS 14C age of subhorizon reaches 46-50 thousand years, and U/Th230 – about 62 thousand years.
24. The Upper Khvalynian subhorizon is represented by two types of deposits. The upper part is a pack of deltaic sands, enriched with vegetable detritus, clay and silt-clay mud with different texture, formed in shallow-water conditions at the beginning of the regression of the sea. The lower part is silty sand sometimes with interlayers of clay. In the composition of shells is dominated by Monodacna, Hipanis, Adacna, Gastropoda. Didacna is presented by D. praetrigonoides, small D. parallella, D. cristata, D. subcatillus, D. barbotdemarnyi. Age the lower border of subhorizon is about 16-17 thousand years BP (more than 19 thousand calendar years).
25. *Mangyshlakian* regressive horizon fills the incised-valley of lake and river types in Khvalynian sediments and is represented by sandy-clay and organic (peat, sapropel) muds. Deposits contain remains of freshwater molluscs, the grass pollen with a small admixture of arboreal pollen. 14C age varies from 10 to 8.5 thousand years BP.
26. *Novocaspian* horizon has a variety of composition and genesis of sediments with close to the modern fauna. According to seismoacoustic data they are presented by four horizontal-layered transgressive packs. There are 3 erosional incisions in horizon, filled with lacustrine-alluvial, sandy-clayey mud with fresh-water and slightly brackish-water mollusks. The lower boundary of the horizon defined at the level of 7-8 thousand years BP.
27. In the deep basin of the Middle Caspian cores discovered deposits of the Khvalynian, the Mangyshlakian and the Novocaspian horizons. Their selection is made according to the diatom and spore-pollen analyses and lithological composition.
28. The Upper Khalynian sediments are represented by blue, light brown and grey mainly clayey muds with interbedded hydrotroilite. They contain a complex of marine brackish diatoms, dominated by marine brackish water species. Freshwater-brackish species with marine species are in small quantity. A significant part of the complex consists of boreal species; a variety of endemic (Central areas), cold-water species are identified in the North-Eastern part of Caspian sea. Down the section, especially in the brown mud, diatom algae are not found. Among the pollen and spores pollen of herbs, xerophytes dominats, but in the upper part of the horizon was marked increase in the proportion of pollen of woody plants.
29. Mangyshlak sediments are represented by light gray, lime-clay silts with interbedded pure carbonate of chemical genesis. The diatom composition is dominated by Actinocyclus ehrenbergii dominates in diatom complex. There are fresh-water and brackish-water species. In spore-pollen complex the pollen of herbs dominates with a slight increase in arboreal pollen.
30. Novocaspian sediments is enriched in organic matter up to the formation of sapropel interlayer, contain interlayers of diatom ooze, and is depleted by carbonate in comparison with Mangyshlakian muds. Their characteristic feature is the domination of planktonic marine species among diatoms, particularly Coscinodiscus radiates. In the composition of tree pollen the number of which has maximum in the sapropel (25-40%), is marked increase in the proportion of broad-leaved trees.
31. Correlation between shallow shelf and deep-sea sections of the Caspian sediments was conducted on the basis of diatom and pollen composition. In addition, in some deep-water cores present were juvenile shells of some species of mollusks, corresponding to shallow complexes.
32. **Conclusion.** Our research allows to correlate sections of the Upper Quaternary deposits of the studied seas and to do some paleogeographic conclusions.
33. The Riss-Wurm and Karangatian sediments on the composition of fauna and flora correspond to the last interglacial period (MIS-5), high standing seas and their sustainable changing of waters, leading to the maximum salinization of the Black Sea (up to 30‰). Their correlation is confirmed by the figures of absolute age. Girkanian deposits of the Caspian Sea, according radioisotopic age partially synchronized with the Karangatian Black Sea sediments. Their relationship in Manich Strait suggests a formation during MIS-5 with a shift in time to the later stages and perhaps the beginning of the last glaciation. The lack of data on deep-sea sediments of this age, however, allow to suppose that in the basin could accumulate sapropel and diatoms as analog of the Novocaspian sediment.
34. The data obtained for the sediments of the Late Pleistocene interstadial allow to make a correlation between The Mediterranean Middle Wurm, the Black Sea Sourozh (?) (middle Valdai), and the Caspian Sea Lower Khvalynian layers. The results of radioisotope (14C AMS and U/Th) age provide the ability to synchronize these sediments at the level of 25-50 thousand years ago (MIS-3). In this case, water of extensive Early khvalynian transgression may to flow in Sourozh basin and maybe then in the Mediterranean Sea.
35. The time of the LGM (MIS-2) is marked by a major regression of the Mediterranean Sea and the Black Sea and less certain of the Caspian Sea. Their age is synchronized at the level of 15-17 thousand years BP.
36. Late - and postglacial sediments (MIS -2 – MIS-1) we identify with the last global transgression of the World Ocean. According to complex data and radiocarbon dating that is the Holocene transgression of the Mediterranean sea (from 17-18 thousand years BP), the novoeuxine-chernomorskaya transgression of the Black Sea (with 15-17 thousand years BP) and late khvalynian-novocaspian (13-15 thousand years BP) transgression of the Caspian sea. The last was interrupted by a deep early Holocene Mangyshlakian regression in the range from 10 to 8.5 thousand years BP.
37. Despite a significant difference of depositional environment in studied basins, the general trend of development of the natural environment in the Holocene interglacial period led to a similar result of the process of sedimentation. This was manifested in the accumulation of sapropel layers. Common cause of their formation is the dramatic increase of phytoplankton productivity due to increased incoming of nutrients into the seas during the Holocene climatic optimum. This is confirmed by the 2-4 fold increase in absolute mass of organic matter in the sapropels compared to the enclosing sediments. According to radiocarbon dating the age of the sapropels was rejuvenated from the Eastern Mediterranean to the Caspian sea, apparently, after the delay time of the occurrence of optimum.
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