cyst assemblages of the southern core change at 10 cal. ka, but from the present day values of salinity (brackish) to a lower salinity. This period of lower salinity correspond to that seen at the base of core CP14, which terminates at c. 4 cal. ka. Therefore the two basins did not have the same water level history leaving a possible role to the Apsheron sill.

CONCLUSIONS

In the absence of a complete palynological record for the Holocene, much remains to be done in the Caspian Sea. In the near future a transfer function for pollen and dinocysts should be developed at the scale of the whole sea. Palaeoclimatic records from marine cores covering a whole climatic cycle with robust age-depth model should be obtained (Cordova et al., 2009).

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PLEISTOCENE CONNECTION AND HOLOCENE SEPARATION OF THE CASPIAN AND BLACK SEAS: DATA FROM THE MODERN KURA DELTA, AZERBAIJAN

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Keywords: Caspian Sea, Black Sea, Pleistocene, paleogeography, Kura delta

INTRODUCTION

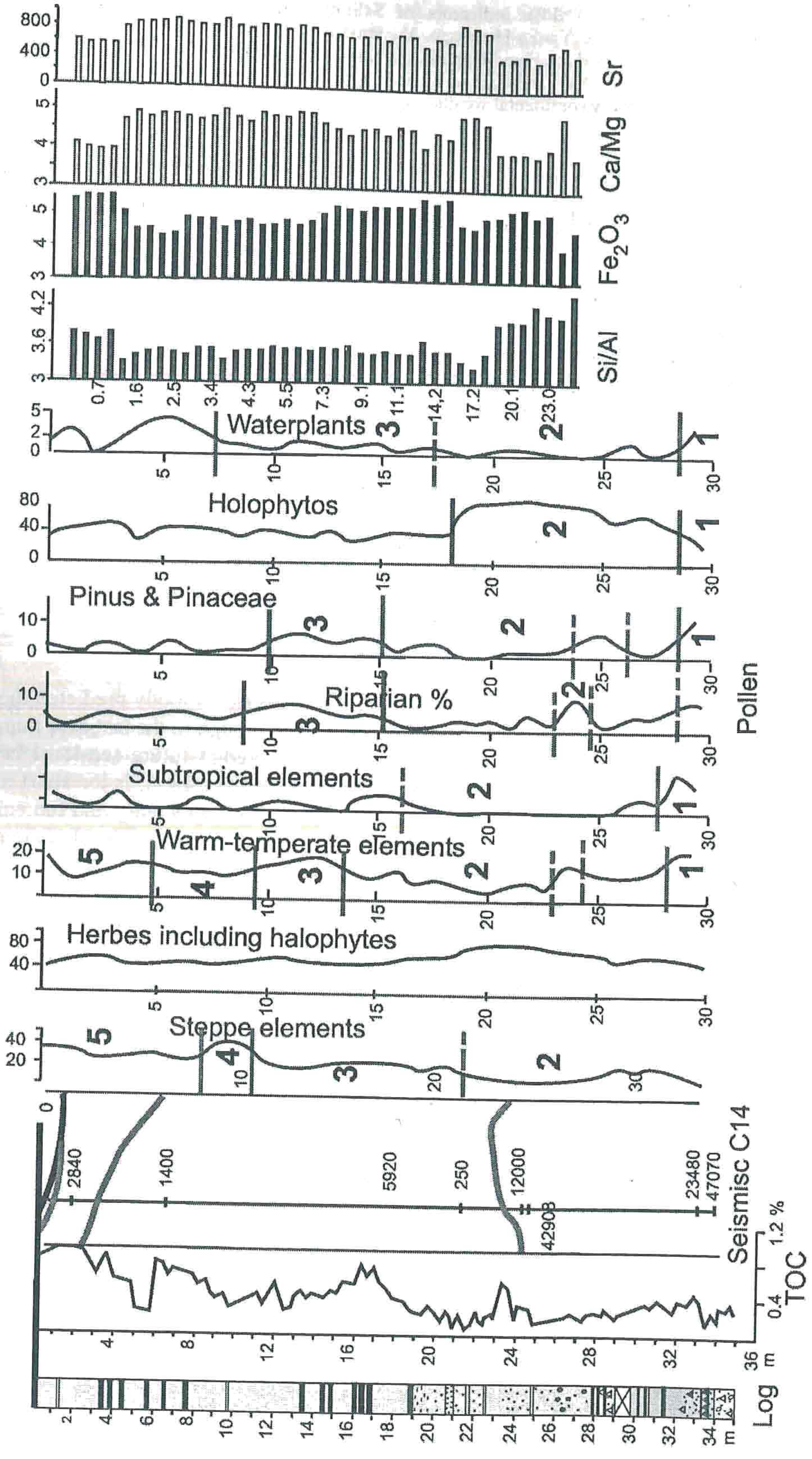
Past breaks in Caspian sea-level trends caught everyone by surprise. Nobody predicted the sharp fall in the thirties, the sharp rise in 1977 and the sudden fall in 1995, even though in the last case numerous Global Circulation Models and hydrological balances have been run to predict future sea-level behaviour. The problem is that the period for which instrumental observations exist, since 1834, is too short to validate any model of long-term trends, and the historical record before that is too fragmentary and too contradictory to derive any reliable trend from them. Therefore we studied paleodata on past sea-level changes in the Caspian area in the Holocene.

One of the most promising sites that can give information both on the absolute elevation and chronology of highstands and lowstands, as well as a semi-continuous record of paleo-ecological conditions, is the modern delta of the Kura river in the southern Caspian Sea in Azerbaijan, a conspicuous fluvial- and wave-dominated delta body protruding offshore until at least 50 m water depth. In an earlier project we recognised the traces of two major lowstands, and two major highstands in the last 1500 years of the Kura Delta history, based on shallow sparker surveys and shallow drilling, sampling and paleoenvironmental analysis.

We now extended the record further back into the Holocene and upper Pleistocene by an extensive seismic survey, drilling and coring of two deep wells, detailed sedimentological, geochemical, paleoecological and chronological analyses. The data have been integrated in a Petrel geological model, visualised using 3-D Inside reality software, and will be matched with the output of 3-D process-based numerical simulation models to be developed for the Kura delta. In this way we obtained a much more detailed and much more reliable Holocene sea-level curve for the Caspian, and especially for the depth and the timing of the lowstands, which are difficult to study on land.

RESULTS

A seismic survey was carried by the subcontractor KMGRU (now KGKTI) in June-July 2007 using an Edgetech subbottom profiler with a maximum penetration of 6 m in sand and 80 m in fine deepwater sediment. In practice only 20-50 m penetration was obtained during the survey. However the quality of the data is considerably better than that of the 2001 survey. Two cores down to 35 m were collected in January, 2009 (Fig. 1).



The first analytical results in the integration of seismic data with grainsize, pollen, geochemistry and 14C dating of core A show a subdivision into four or five sequences, which however do not strictly coincide.

1. Seismic data show three major reflectors, the deepest one of which at ~ 24 m depth (orange reflector in figure above) seems to correspond with the Pleistocene-Holocene boundary according to 14C dating. This might coincide with the occurrence of reddish clays in the log, though they start at a deeper level. Ages range between 23480 and 47070 cal yr BP. Geochemical data show higher values for Si/Al, Ti, Fe_2O_3, Ni, Cr and lower values for Ca/Mg, Sr and TOC than later horizons. Pollen biozone 1, which might coincide with this unit, shows high amount of *Pinus* and water plants and low halophytes, suggesting a large influence of fresh water and pollen influx from the Volga through coast-hugging marine currents. These sediments resemble in many aspects the brownish Late Pleistocene sediments recovered from the deepest part of the South Caspian Basin (Chalié et al., 1997; Jelinowska et al., 1998) and also to some extent the so-called 'chocolate clays' recovered from the bottom of the Black Sea (Bahr et al., 2005, Hiscott et al., 2007) and cropping out in the North Caspian Plain (Badyukova, 2005).

2. Close to this (orange) reflector, at 24,55m depth, peaty sediments were found dated at 12000 cal BP, also characterised by a peak in TOC. This sequence is characterised by a high content of halophytes (Biozone 2), suggesting deposition under salt marsh conditions close to sea level. This is not a distinctive sequence in the seismics. Geochemical data indicate the lowest contents in Fe_2O_3 of the whole core, low Ni, Co, V and comparatively high Ca and Sr contents. In view of the water depth of the top of the core at 40.13 m, sea-level must have been almost 65 m lower than the present one of -27m below oceanic level, i.e. -92m (24,55+40,13+27m) below oceanic level. This is within the range of estimates for the Early Holocene Mangyshlak regression (Varushchenko et al, 1987).

3. The third horizon from ~24 m up to the next reflector (green in the figure) at about 4-8 m depth, consists of greyish marine muds with minor sand intercalations, and in which several cycles can be discerned on the basis of TOC contents. Ca and Sr contents are much higher than in horizon 1, whereas Ti, Fe_2O_3, Ni and V are substantially lower. This series shows increasing contribution of warm temperate pollen, increasing (Volga-derived) *Pinus* and Kura-riparian pollen, and decreasing halophytes, suggesting a rising sea level. Two 14C ages have been obtained for this interval, 5920 cal BP at 17.20m, and 1400 cal y BP on a large mollusc at 6 m depth, close to the strong reflector at the top of this unit. This horizon therefore spans a major part of the Holocene. The upper age is very similar to earlier ages obtained from the Kura delta close to the same reflector, interpreted as indicating the 6th century AD Derbent lowstand known from historical data, which may have been as deep as -48 m (Hoogendoorn et al., 2005). The depth of the upper boundary of this unit varies to some extent in the different analyses. The lowstands may correspond with the Warm Mediaeval Period (Kroonenberg et al., 2007, 2008).

4. The unit on top of the 'green' reflector, generally between 1,5 and 6 metres depth, and possibly limited at the top by the yellow reflector, is not well individualised in the lithology:greyish and green muds predominate. The contents of Si, Fe_2O_3, Cr, Ni, and V seem slightly lower than in adjacent units, while Ca, Mg, Sr and TOC are higher. There is a definite peak in steppe pollen (*Artemisia*, *Ephedra*) and a dip in the warm temperate pollen, indicating warm semi-arid conditions. The only 14C date from this horizon is 2840 y cal BP, the *Didacna* specimen used for dating was apparently reworked. On the basis of the analogy with earlier data from the Kura delta (Hoogendoorn et al; 2005), this unit may well represent the Warm Mediaeval Period between the lowstands of the 6th and 12th entury AD.

5. The uppermost ~ 1,5 m between the yellow reflector and the surface shows a tendency to cooler climatic conditions according to the pollen profiles, and thus may correspond to a period of sea-level rise heralding the start of the Little Ice Age highstand (cf. Kroonenberg et al., 2007). The shales in this interval are slightly richer in Fe_2O_3, Ni, Cr, V, Zn and lower in Ca, Mg and Sr than the underlying horizon. Well B shows similar characteristics in seismics, lithology and geochemistry, but no palynological data are available yet. The geochemical contrasts between the lowermost Fe-rich and Ca-poor units and the upper Fe-poor and Ca-rich units are particularly striking. Three ages have been obtained, one >45000 in what is presumably Unit 1, one 17500 BP in Unit 2, and one 9240 cal. BP in an equivalent of unit 3.

SiO_2/Al_2O_3, Fe_2O_3, Ca and Sr in Well B One of the most important conclusions that can be drawn from the project is the similarity in Late Pleistocene sedimentation in the Caspian and in the Black Sea, suggesting that this unit was deposited when both seas were united during the last major Glacial highstand (Khvalyn) of the Caspian (so-called chocolate clays). Those in the Black Sea might therefore either originate directly from an overflow of the Caspian, or proceeding from drainage basins that have similar characteristics as the rivers discharging in the Caspian Sea. The striking difference in geochemical characteristics between the Pleistocene (high Fe, low Ca) and Holocene (low Fe, high Ca) sediments corroborate earlier findings from deep sea cores in the Caspian, and point to major changes in the drainage basins feeding the Caspian Sea during the Late Glacial-Holocene transition.

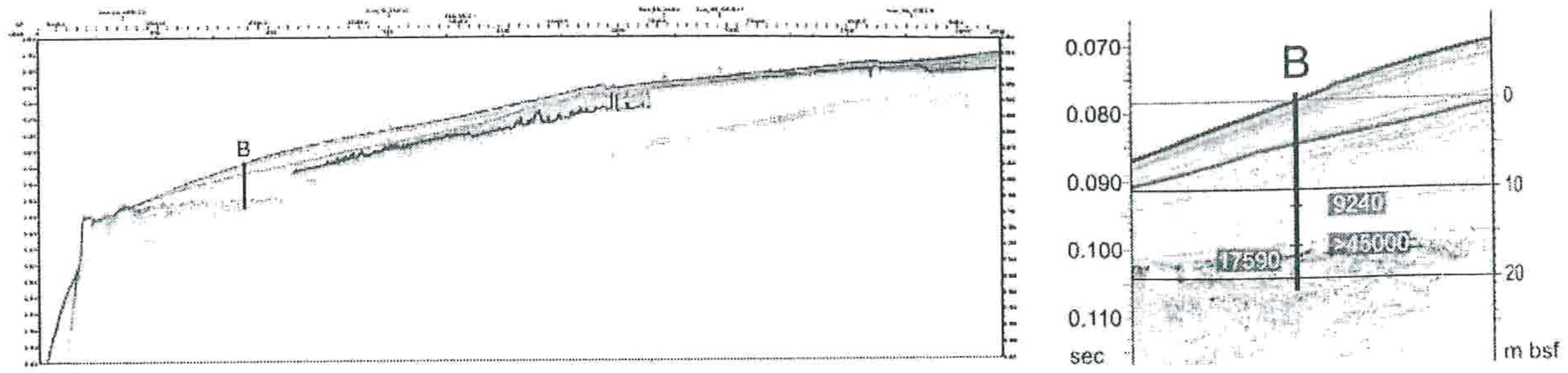


Fig. 2. Interpretation – Core B

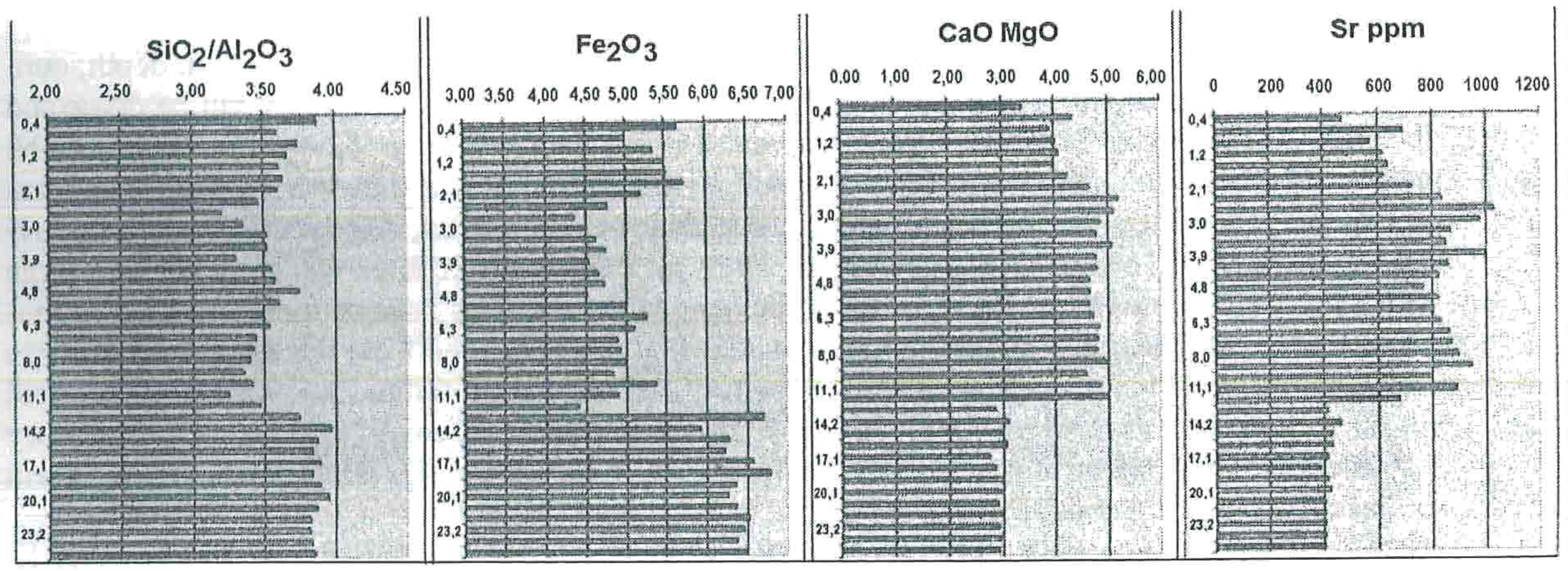


Fig. 3. SiO_2/Al_2O_3, Fe_2O_3, Ca and Sr in Well B

Holocene sea-level cycles, the main subject of this project, are clearly discernible in the palynological and TOC data, and seem to conform to earlier less precise data, but we are awaiting more 14C data to see the finer details of sea-level change. After all, the best sealevel curve from the Caspian will combine results from an integration of data from all sites studied so far by us in this and other projects in the Caspian Sea, in which the Kura data provide the best data for dating the lowstands. The data collected in this project make the necessary data base complete enough to give a comprehensive picture of Holocene Caspian Sea level change in our forthcoming publications.

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ENVIRONMENTAL GEOCHEMISTRY OF THE CASPIAN COASTAL ZONE

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Keywords: environmental geochemistry, coastal zone, Caspian Sea, Volga delta

INTRODUCTION

Presently the Caspian region draws a great attention of researchers due to the rapid fluctuations of the sea-level and increase of the anthropogenic load. In 20th century the Caspian Sea showed a full sea-level cycle with amplitude of about 3 m, which included stages of regression (1929-1977) and transgression (1978-1995). Rapid sea-level fall had a number of negative consequences: shallowing of the near-shore waters, deterioration of shipping conditions, decrease of feed areas for fish in the Northern Caspian, increase of soil salinization in the coastal zone, intensification of eolian processes, etc. The sea-level rise caused even more serious environmental consequences: flooding and water-logging of vast areas, destruction of the seashores, strengthening of wind-induced surges, development of hydromorphism and salinization processes in the coastal landscapes.

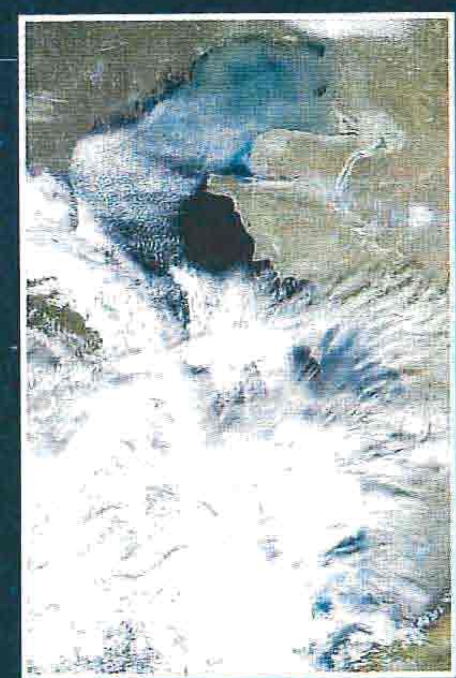
Another problem of the region consists in the environmental state of river mouths, which are located at the contact of riverine and marine waters and influenced by pollutants brought by rivers. Recently a problem of the environmental state in areas of oil and gas extraction is put in the forefront. This is caused by rapidly increasing offshore exploration, extraction and transportation of oil and gas in the Northern Caspian Sea. It results in strengthening of anthropogenic load on the coastal and aquatic systems, and dramatic rise of environmental risks due to possible accidents. Of a special concern is environmental state of wetlands within the Volga River mouth area which are of international importance due to Ramsar Convention.

From the beginning of 1990-ies the Caspian Sea coast was studied in frames of a number national and international projects devoted mainly to the geochemical consequences of the sea-level fluctuations for the coastal landscapes, and also environmental state of river mouths.

GEOCHEMICAL CHANGES IN COASTAL ECOSYSTEMS

Geochemical changes in coastal soils and sediments were studied in detail in Turali area (Central Dagestan). Besides, similar research was done at accumulative lagoon shores of Azerbaijan and Iran. The study showed that along accumulative shores the sea transgression gives rise to geomorphological, lythological, soil, biotic, as well as geochemical diversity of the coastal landscapes. This is caused by formation of bar-lagoon system moving landwards, inundation and water-logging processes, with a corresponding rise of the groundwater table, and also simultaneous vigorous development of vegetation in newly-formed hydromorphic and semi-hydromorphic areas. On the contrary, the sea regression leads mainly to the passive drowning of the shore zone with a following decrease of the coastal environment variability.

Geochemical conditions of the coastal landscapes are also caused by the sea-level fluctuations. Regressive stages associate with a weak variability of geochemical environment in sediments and soils. They are characterized mainly by alkaline oxic conditions, and salinization as a leading geochemical process. Geochemical diversity of the coastal zone during transgressive stages is much higher. Conditions vary from neutral to highly-alkaline, and from oxic to highly unoxic. Newly-formed geochemical processes are presented by sulfidization, gleyzation, ferrugination, organic matter accumulation, and salinization. They cause a formation of various contrast geochemical barriers in soils and sediments with a consequent redistribution of chemical elements. These processes take place on the general low background of microelements which is characteristic for the Russian part of the Caspian seashore. Content of heavy metals is essentially higher in coastal soils and sediments of Azerbaijanian and Iranian seashore, especially in the South-Western area of the Caspian.



The Caspian Region:
Environmental Consequences of the Climate Change

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