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Climate of the Past Discussions

Interactive comment on "Caspian Sea level changes during the last millennium: historical and geological evidences from the south Caspian Sea" *by* A. Naderi Beni et al.

A. Naderi Beni et al.

amnaderi@inio.ac.ir

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Dear Reviewer

Thank you for reviewing the article.

Please see below for our responses to your comments.

Comment 1:

The apparent objective of this paper is to use historical and geological data to establish ancient surface-level of the last millennium Caspian Sea and discuss climate mechanism that controlled the level changes.

Response:

The reviewer has correctly highlighted the main objective of the paper. Moreover, we used the historical evidence to reduce uncertainties relating to the pre-instrumental geological data as a secondary objective. Due to a lack of any calibration database for the chronological data of the Caspian Sea shells, this approach helps us to link the geological findings with historical observations and estimate the exact date of major Caspian sea-level changes. As local irregularities such as vertical movements of the coasts, seiche and river avulsions might be partly underpinned by climatically driven sea-level changes, we paid attention to the historical evidence of local irregularities to differentiate the local sea-level changes from climatically driven Caspian Sea level oscillations. We will make sure this aim appears in a clearer way at the end of our introduction.

Comment 2:

While this objective is certainly legitimate and the combined use of historical with geological data is desirable, the reader is drowned in a kind of long overview descriptions of the geography, limnology, hydrology, seismic, history, etc of the Caspian Sea and its vicinity and then (after a very short description of the geological methods) a very long and detailed description of the historical evidence. In fact, most of the rest of the paper is also a kind of an overview-discussion on the various interpretations of the historical evidence.

Response:

To compare the historical and geological evidence, we had to conduct a comprehensive literature review in many languages, which is summarized in pages 1406 to 1417. To test the accuracy of paleoenvironmental findings, we drilled two short cores from the south-east Caspian Sea (1404/24-25 & 1405/1-20) and compared the results with other geological and historical findings (Fig. 9). Dating young geological records by radiocarbon ages leads to several uncertainties that are highlighted in our study by correlations with historical documents. Therefore in our case this geological-historical comparison is not a dispersion or distraction but a synergy.

Although we tried to give a detailed description of the region, some readers also asked more details about the geographical setting (Clim. Past Discuss., 9, C256–C257, 2013) or adding more historical citations to the manuscript (Clim. Past Discuss., 9, C148–C149, 2013; Clim. Past Discuss., 9, C621–C623, 2013).

Considering the vast area of the Caspian Sea, many different coastal types exist and consequently, they respond differently to the sea level changes. It is therefore necessary to review various geological interpretations from different coastal setting and compare them with widespread historical observations. This integrated approach is more appropriate to reconstruct the Caspian Sea level changes than focusing on a small area with limited records of sea-level changes.

The comprehensive literature review of this paper is necessary to reconstruct the Caspian Sea level curve.

Comment 3:

The only relevant section that deals with geological evidence is that with the Radiocarbon dating of the core and some, mineralogical and magnetic susceptibility description and interpretation. The very short parag on the magnetic susceptibility (p 1406 to 1407) is confusing and does not really tell us whether they identified the "suspected minerals" (e.g. they write "could be linked to: : :) and t OK, then what ?

Response:

We have summarized geological evidence in Tables 1, 2, 4, 5, 6 and 7 and discussed them in pages 1417 to 1422 as they deal with geological evidence of Caspian Sea level changes. We have used the core data to compare them with the reconstructed curve and independently test the accuracy of palaeo-environmental data. The results show a good agreement between the paleoenvironmental data and the geological and

historical findings. For example, on page 1407 (1-15) we showed that the marine facies of the cores are representative of an open lagoon environment with fresh water influence which could be correlated with the historical observations of Mostowfi (1999) about the formation of Nim-mardÄĄn Bay and the rapid sea-level rise recorded by Kakroodi (2012) as a shell-bearing layer on the south-eastern flank of the Caspian Sea.

Magnetic susceptibility measures the magnetisability of a material (Dearing, 1999). In sediments, it depends largely on the mineralogy of materials particularly to Fe-bearing minerals as well as the grain size. As the sediment composition largely depends on the sediment source, the magnetic susceptibility is a useful tool to make inferences about sediment sources (Waythomas and USGS, 1991). According to increasing biochemical activities in marine environments, which are reflected in marine deposits and concentration of Fe-bearing minerals in detrital deposits which are common in terrestrial deposits, we expected lower values of magnetic susceptibility of the marine facies in the sediment cores (Fig. 4). Moreover, the grain size of the terrestrial deposits in the core is generally larger than the marine deposits (Fig. 4). Surprisingly, we observed lower magnetic values in the terrestrial deposits which is in contradiction with the assumption. So, it is logical to link this apparent contradiction to the source of the sediments. As it was mentioned in the text (p. 1407), the feeding watercourses of the coring site have their headwaters in the Kopeh DÄĄgh that is mantled in calcareous deposits which have less magnetic susceptibility. The higher values of the magnetic susceptibility in the marine facies could be linked to the presence of paramagnetic minerals which are transported by longshore currents from the southern coast of the Caspian Sea (Ibrayev et al., 2010). The paramagnetic components of the southern coast deposits are provided by igneous and metamorphic rock outcrops of Alborz Mountains (Lahijani and Tavakoli, 2012).

The sedimentological results show that during the Little Ice Age highstand, the southeast Caspian coast was inundated and a relatively shallow open lagoon/bay was formed that is corroborated by the presence of lagoonal gastropod fossils. The lagoon/bay had connection with the sea as it was interpreted based on the presence of marine bivalves and gastropods and influenced by the fresh waters due to the presence of charophytes. Mostowfi (1999) also (Kuzmin et al., 2007)mentioned that a bay existed on the south-eastern flank of the Caspian Sea in the 14th century, near ÄĂbeskun where Gorganrud was discharging into the lagoon. He called the bay as Nim-mardÄĄn Bay (the Half-men Bay). Attributing the name of Nim-mardÄĄn to the bay could be interpreted as a shallow-water bay in which fishermen could stand in order to fish (Nahchiri, 1999), as they do today in GomishÄĄn. The area of the bay changed in accordance with the Caspian Sea fluctuations, characterized by emerging during the 16th century lowstand (Fig. 9) and then covered by fluvio-deltaic deposits of the rivers or streams that originated from Kopeh DÄĄgh. After that, the bay came to exist again during the 17th century highstand and persisted until the 19th century (Fig. 9) when it was mapped by Indian geographers (Kakroodi et al., 2012) and was named as Hassangholi Bay.

Following the comment of the reviewer we are going to add some additional details to our manuscript.

Comment 4:

Even the very short discussion of the “sedimetological and mineralogical data” is read as a kind of short overview of previous works (p 1407).

Response:

Mineralogical, sedimentological and paleontological data are new and are being prepared for publication as a separate paper. However, we supported our findings and interpretations by other literature. We did not extend the details of the sedimentological data because it is not the subject of this paper.

Comment 5:

The radiocarbon ages were determined on shells.

Response:

The chronology was based on shell dating because: 1: The shells are the most abundant material in the cores for dating (Fig. C1); 2: We chose articulated shells that are representatives of the same horizon without any risk of transporting and reworking; 3: We wanted to compare the dating results with previous works including Rychagov (1997), Karpychev (1998; 2001), Lahijani et al. (2009) and others who mostly dated the sea-level changes based on shell chronology.

Comment 6:

No word on hard water or reservoir age correction that can reach hundreds to thousand of years. We get no information on the reservoir age of the current water or anything that could help to constrain the reservoir ages. Thus, the chronology could be completely offset.

Response:

We have discussed the age data on pages 1405 (16-20) and 1407 (16-23) and the reservoir effects (RE) on pages 1419 and 1423(16-23). In page 1419 (12-13) we mentioned that “Various RE have been reported for the CS: from 290 to 400 yr by different researchers (Leroy et al., 2011).” As it was mentioned in the paper, at present there is not any RE database for the Caspian Sea and only some discrete studies have been conducted to estimate the RE (see summary in Leroy et al., 2011). For example, some of the reported RE ages are: 383 yr in Leroy et al. (2007), 290 yr in Kroonenberg et al. (2007), 390–440 yr in Kuzmin et al. (2007), and 345 to 384 yr in Karpychev (1993). So, precisely constraining the RE for the CS is a high priority for future studies (P. 1423/20-21). The comparison between the core data and the historical-geological outcomes (Fig. 9) show that using the Marine09 database for calibration of 14C ages yields more reliable results for the Caspian Sea (P. 1423). When consulting online the Marine 09 database, one can see that this finding is supported by the findings of Kuzmin et al. (2007). Actually, the historical data helped us to reconstruct the Caspian Sea level curve as a calibrated curve. We put our age data on the curve (Fig. 9) to get an estimate of the RE of the Caspian Sea.

Comment 7:

Paper should consider the geo-science and/or paleo-climate community (e.g. for a forum of Climate of the past)

Response:

Limiting the paleo-environmental studies to a special community is the worst option in studying the past climate. The multidisciplinary approach leads to a better understanding of past environments and, moreover, it helps to corroborate the accuracy of geological findings. As it was mentioned in the paper (e.g. pages 1399, 1400, 1409, and 1423), the Caspian Sea level changes which are driven by the climatological factors, have had socio-economic impacts on the coastal communities. For example, the 1304 AD rapid sea-level rise accentuated the demise of the Khazars dominion on the northern coast of the Caspian Sea and wiped out ÄĂbeskun completely in the south-east of the sea. On the other hand, historical events such as major tribal migrations and the waxing and waning of civilizations could be a sign of main environmental changes that help the geo-scientists and paleo-environmentalists to focus their studies on the same era to find the environmental reasons as well as the socio-economic impacts. If both historians and geologists are satisfied by the quality of our work, our manuscript should be considered as a successful example of building bridges between communities, and praised for it.

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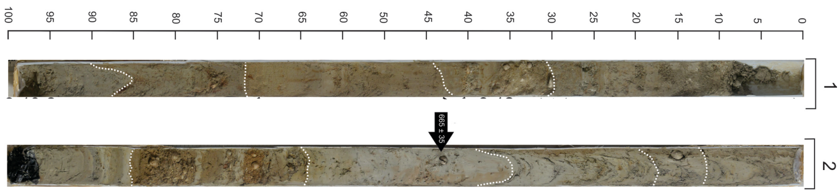

Fig. 1. Fig. C1. The photo of short core A in south-east Caspian Sea (please see the position of the core in Fig. 1 in the paper). The dated horizon, an articulated bivalve, is marked by a black arrow.