Geography and Development
$10^{nd}$ Year - No. 29 - Winter 2013
Received : 31/1/2012 Accepted : 17/7/2012
PP: 28 - 31

## Ancient Modeling of Hydrology Based on Comparison of $\delta o^{18}$ Carbonate and the $\delta o^{13}$ Crbonate Parishan Lake (Fars Province)

**Dariush Noorollahi**
M.Sc Climatology
University of Shahid Beheshti

**Dr. Hassan Lashkari**
Associate Profesor of Natural Geography
University of Shahid Beheshti

**Maria Amirzade**
Faculty of Earth science
University of Shahid Beheshti



### Introduction

stable isotopes are strong tools for environmental studies, because most of the elements are naturally more abundant at least in one isotope. Among the studies, many researchers have considered the Carbon ($C^{13}/C^{12}$), Oxygen, ($O^{18}/O^{16}$) Hydrogen ($H^2/H$) and Nitrogen ($N^{29}/N^{28}$) which remain effects on the organic (plants and animals) and inorganic (water, soils, rocks, fossils,...) material (Griffiths, 1998, p47). In order to study the Carbon and Oxygen stable isotopes of the lake carbonates, recognizing the effective factors on the isotope's value and identifying the relationship between the isotope values is essential. In the lake environments many factors can determine the variability of the Oxygen isotopes of the lake sediments which the most important of them are including: source of materials, water temperature, residence time and the input and output amount of the lake (Benson et al, 1996, p747). In the open hydrological systems, the Oxygen isotope components of the lake water dominantly reflect the isotopic components of precipitation (rain and snow) (Leng& Marshal, 2004, p817). In addition to the effective factors on the isotopic amount of carbon and oxygen, the relationship between the carbon and Oxygen isotopes in lake systems can deliver valuable information about the history of the lake's hydrology. The relationship between the isotope values of carbon and oxygen isotopes in the closed lakes can be based on the hydrological changes, evaporation, biomass production and the Co2 concentration (Le and Ku, 1997, p72). There are big hydrological closed lakes especially in the arid regions, which both carbon and oxygen isotopic values are positively high. In these cases, it shows a close value of correlation .the magnitude of the correlations can be used to estimate the closeness of the lakes in different time periods. In the closed lakes, the covariance of carbon and oxygen isotope values generally indicate the interaction of carbon and oxygen isotopes with the atmosphere (Tanner, 2009, p210). In fact, the strong correlation between the carbon and oxygen isotope values indicates a common effective mechanism on the lake dissolved inorganic carbon (DIC) (Eastwood et al, 2007, p239). In the open lakes, there is a prefencally weak correlation between the carbon and oxygen isotope values. In fact, generally, the the strong correlation between the carbon and oxyegen isotope values ocuurs in the lake that have a long residence time. The correlation values more than 0.7 indicate the lake carbonates deposited in a hydrological closed lake. Furthermore, in these cases, due to the high variability of the lake water, the oxygen isotope values in the closed lake are approximately around 0.0 %. Therefore, this covariance could be used to estimate the closeness of the lakes with the carbonates deposition (Talbot, 1990, p273). Based on the methods mentioned above, a core was taken from Parishan lake in Fars. The aim of this research is to reconstruct the hydrological condition of the lake in the past using the Carbon and Oxygen stable isotopes of the Ostracoda microfossil.

**Method and Materials**

The carbon and oxygen isotope components were measured in Otava university, the Faculty of Science (Earth Sciences) (G.G. Hatch Isotope Laboratories, 130 Louis Pasteur). Totally, 36 analyses of carbon and oxygen isotope were made on 33 samples. The accuracy of measurement analyses has been reported ± 0.1 per thousand. The isotope components of samples based on the well- known scale of δ have been defined and reported as per thousand.

$\delta_{sample}$ (‰) = $[(R_{sample} - R_{standard}) / (R_{standard})] \times 1000$

Where R refers to the accumulative ratios of the $O^{18}/O^{17}$ and $C^{13}/C^{12}$ in the samples and shows the isotopic standard reference. In this research both of the carbon and oxygen stable isotopes are reported based on the vpdb standards. Also the below equation is suggested in order to convert this standard into the vsmow standard.

VPDB-VSMOW $d^{18}O_{vsmow} = 1.0309d^{18}O_{vpdb} + 30.92$

VSMOW-VPDB $d^{18}O_{vpdb} = 0.97001d^{18}O_{vsmow} -29.99$

**Discussion**

According to the variation of the isotope values of the carbon and oxygen elements, three below zones were defined in order to survey the environmental changes separately.

Zone 1: (900 to 1800 BP)

When water evaporates from surface of Parishan lake, watervapor is enriched by H and 16O, because $H_2{}^{16}O$ has a higher watervapor in comparing with HDO and $H_2{}^{18}O$ (Hoefs ,2004). So the increase of evaporation enriches the lake water and consequently the carbonate of $H_2{}^{18}O$.

The $\delta O^{18}$ values are relatively low in this zone. This indicates that evaporation had not a significant effect on the $H_2{}^{16}O_{lake\ water}$. As a result, Parishan Lake experienced a wet condition during this time. Furthermore, the weak correlation between the carbon and oxygen stable isotope values indicates that the lake was hydrologically open and was fed by the underground water during this zone. The existence of gypsum crystal only in this zone can show a higher fed of under ground water in to the lake. Consequently, the P+G=E is the suggested hydrological equation for this zone.



Zone 2: (200 to 900 BP)

The carbon isotopes values in this zone are relatively higher than the previous zone. Increasing the carbon isotope values could be a result of decreasing the underground water discharge into the lake. The higher $O^{18}$ suggests a drier climatic condition. In fact, the higher $O^{18}$ during this zone caused by removing the $O^{17}$ by evaporation. The weak correlation between the carbon and oxygen isotope values suggests an open condition of Parishan Lake in this zone. Consequently, the lake level was relatively high in this zone. However, the higher oxygen isotope values and the weaker correlation indicates that the lake level was lower than the previous period.

Zone 3: (Two recent centuries)

There is an abrupt and significant change in the $C^{13}$ values in this zone. The carbon isotopes values exceeds 0 in this zone. The strongest correlation between the carbon and oxygen isotope values is observed in this zone. Totally, the isotopic analysis in this zone shows that 1: the increase of carbon isotopes indicates the decrease of underground water discharge considerably in this zone. 2: the strong correlation of carbon and oxygen isotope values suggests that the lake experienced a closed condition in this zone, evaporation is a common effective factor which controls the variations of both carbon and oxygen isotope values. 3: the anthropogenic effect is an additional factor that controls the significant change of the lake hydrology. 4: the P=E equation is suggested for this zone and the current hydrological condition also indicates that evaporation and precipitation are the main effective factors on the lake hydrology.

## Conclusion

The gradual increasing of the $O^{18}$ values indicates a weak dry trend during the study period. Also the investigation of the isotope carbon show that the underground water recharges variation controlled the carbon stable isotope values. The carbon isotope changes are caused by the underground water discharge variation during different time periods. The results show that the hydrological equation of the Parishan Lake has changed during the time period as this lake experienced an open condition in the past. However, at the present, as a result of the human impact, the lakes become a closed lake where the evaporation and precipitation are the main effective factor that controls the hydrology of the lake. In the final part of the study term (zone 3) the abrupt change of the $O^{18}$ suggests the impacts of the human on the lake's environment.

**Keywords:** Palaeohydrology, Stable carbon and oxygen isotopes, Parishan Lake.

## References

1. Aghanabati, Seyed Ali (2004). Geology of Iran, industry and mining boreua. The gology and mining organization of Iran.
2. The water management organization (2009).
3. Shahrabi. Mostafa (1994). gology of Iran( Lakes and Seas). Publication of the Glogology organization of Iran.
4. Massodian, Abolfazl (2003). Recognizing the percipitation patterns using the cluster analysis. Geography researches. No 52.

5. Andrews, J. E, Riding, R., Dennis, P. E (1997). The stable isotope record of environmental and climatic signals in modern terrestrial microbial carbonates from Europe. Palaeogeography, Palaeoclimatology, Palaeoecology. 129.
6. Eastwood J.Warran, Melanie J.Leng, Neil .Robert and Basil Davis (2007). Holocene climate change in the eastern Mediterranean region; a compartion of satble isotope and pollen data from Lake GO lhisar, southwest Turkey, Journal of quaternary Science 22(4).
7. Editorial (2008). Lake system; sedimentary archives of climate change and tecnics. Palaeogeography, Palaeoclimatology, Palaeoecology 259.
8. Fan,Majie. David L. Dettman, Chunhui Song,Xiaomin Fang , Carmala N. Garzione (2007). Climatic variation in the Linxia basin, NE Tibetan Plateau,from 13.1 to 4.3 Ma: The stable isotope record. Palaeogeography,Palaeoclimatology,Palaeoecology 247.
9. Gates, David Murray (1993). Cliamte change and its biological consequences. Sunderland, Mass; Sinauer Associates 551 .6973.G259C.
10. Griffiths, H (1998). Stable Isotopes; integration of biological, ecological and geochemical processes. oxford; Bios Scientific Publishers, 551.9 G855S.
11. Hoefs, Jochen (2004). Stable isotopes Geochimistery. Berlin; Springer. 551.9H693S.
12. Jones, Matthew. Palaeoclimatic research within the Mamasani Archaeological Project. Unpublished data.
13. L.V. Benson, J.W. Burdett, M. Kashgarian, S.P. Lund,F.M. Philips, R.O. Rye (1996). Climatic and hydrological oscillations in the Ownes Lake Basin, and adjacent Sierra Nevada,California, Science 274 746-749.
14. Leng.J .Melanie, and Jim D.Marshal (2004). Palaeoclimate interpretion of stable isotope data from lake sediment archives.Quaternary Science Reviews 23.
15. Li.H.c and Ku T.L (1997). δO18 - δ C13 covariance as a palaeohydrogical indicator for closed-basin lakes. Palaeogeography,Palaeoclimatology,Palaeoecology, Volume 133, issues 1-2.
16. Stable Isotopes and mineral resource investigation and palaoclimateic interpretion
17. Talbot, M.R (1990). A review of the palaeohydrologocal interpretation of carbon and oxygen isotopic ratios in primiary lucustraine carbonates. chemical geology; Isotope geosciences section, volume 80, issue 4, 1.
18. Tanner, H.Lawrence (2010). Chapter 4 continental carbonates as indicators of palaoclimate. Developing in sedimentology, Volume 62.
19. Wang. R.L, S.C. Scarpitta, S.C. Zhang, M.P. Zheng (2002). Later Pleistocene/Holocene climate conditions of Qinghai^Xizhang Plateau (Tibet) based on carbon and oxygen stable isotopes of Zabuye Lake sediments. Earth and Planetary Science Letters 203.
20. Xu.Hai, Li Ai, Liangcheng Tan, Zhisheng An (2006). Stable isotopes in bulk carbonates and organic matter in recent sediments of Lake Qinghai and their climatic implications, Journal Chemical Geology. Volume 235.