Certificate

Maliheh Pourali, Adel Sepehr, Mohamad Hosein Mahmudy Gharaie

This is to certify that your paper entitled

A Quaternary study by mineral compositions along salty-clay surfaces of Sabzavar dry-lake playa

Presented by

Dr. Maliheh Pourali

in Iranian Quaternary Association 1st International & 3rd National Congress, that was held in the Geological Survey of Iran, 13-14 February.

Ph.D. Ghasem Azizi
Scientific Secretary

IRQUA

Ph.D. Fariborz Gharib
President of Irqua

Secretariat Address: Research Center Of Geological Survey Of Iran, Sarbazane Gomnam Boulevard, Shahid Naghdi Street, Standard Square, Karaj.
Tell: +98 02632821000- **cell**: 09335057094
Email:Irqua2014@gmail.com **Web**: WWW.Conf.iranqua.ir

IRQUA

IRANIAN QUATERNARY ASSOCIATION
FIRST INTERNATIONAL & 3rd NATIONAL CONGRESS
13-14 february 2018

Certificate

Maliheh Pourali, Adel Sepehr, Mohamad Hosein Mahmudy Gharaie

This is to certify that your paper entitled

A Quaternary study by mineral compositions along salty-clay surfaces of Sabzavar dry-lake playa

Has been selected as a TOP PAPER in Iranian Quaternary Association 1st International Congress, that was held in the Geological Survey of Iran, 13-14 February

Ph.D. Ghasem Azizi
Scientific Secretary

IRQUA
Iranian Quaternary Association

Ph.D. Fariborz Gharib
President of Irqua

Secretariat Address: Research Center Of Geological Survey Of Iran, Sarbazane Gomnam Boulevard, Shahid Naghdi Street, Standard Square, Karaj.
Tell: +98 02632821000- **cell**: 09335057094
Email:Irqua2014@gmail.com **Web**: WWW.Conf.iranqua.ir

- Delorme, L.D (1970c). Freshwater ostracodes of Canada. Part III. Family Candonidae. Canadian Journal of Zoology 48:1099–1127.
- Delorme, L.D. (1968). Pleistocene freshwater Ostracoda from Yukon, Canada. Canadian Journal of Zoology 46:859–876.
- Hamzehpour B (1998). Geological map of the izadkhast. Tehran, geological survey of iran, scale 1:100,000.
- IPCC (2001). Climate chenge: the IPCC scientefic assesment. Houghton,J.T, jenkins.G.J, Ephraums J.J (ede) Cambridge university press,Cambridge.
- Jackson M.L (1979). Soil chemical analysis- advanced course. 2nd edition, published by the author, Madison, Wisconsis, page: 895.
- Khodami M, Noghreyan M, Davoudian A, Norbehesht I (2009). Pliocene–quaternary adakite-like volcanism in the isfahan area, central iranian magmatic belt: neues jahrbuch fur mineralogie-abhandlungen, vol 186(3), pp: 235–248.
- Kienast F, Schirrmeister L, Siegert C, Tarasov P (2005). Palaeobotanical evidence for warm summers in the East Siberian Arctic during the last cold stage. Quaternary Research,vol 63, pp: 283-300.
- Meyers P (1997). Organic geochemical proxies of paleoceanographic, paleo-limnologic, and paleoclimatic processes. Organic geochemistry, vol 27, pp: 213-250.
- Meyers P. A, Lallier-Vergès E (1999). Lacustrine sedimentary organic matter of late quaternary paleoclimates. Journal of paleolimnology, vol 21, pp: 345-372.
- Sai K (2004). Geochemistry of lake sediments as a record of environmental change in a high arctic watershed, chemie der erde, vol 64, pp: 257–275.
- Stocklin J (1980). Stractural history and tectonic of Iran. A review, aapg. Bull. Tulsa. Oklanoma, vol 52(7), page: 1231.
- Zahedi M (1976). Geological map of Shahreza: Tehran, geological survey of Iran, scale 1:100,000.
- Zahedi M, Samadian M, Taavosian Sh, Amidi M (1978). Geological map of isfahan: tehran, geological survey of iran, scale 1:250,000.

A Quaternary study by mineral compositions along salty-clay surfaces of Sabzavar dry-lake playa

Maliheh Pourali ;PHD candidate geomorphology; Dept. of Physical Geography, Ferdowsi University of Mashhad, Mashhad, Iran.
maliheh.poorali@yahoo.com
Adel sepehr; PHD geomorphology; Dept. of Desert and Arid Zones Management, Ferdowsi University of Mashhad, Mashhad, Iran.
adelsepehr@aol.com
M.H. Mahmudy Gharaie; PHD geology; Dept. of Geology, Ferdowsi University of Mashhad, Mashhad, Iran.
mhmgharaie@um.ac.ir

Abstract:
We studied mineral and deposition records in a dry lake playa, Sabzevar, northeastern, Iran. For sampling soil and depositional records, 12 samples were taken along Playa surfaces including firm puffy ground, clay-carbonate plain, and salty pan with the dominance of Halite salts. All profiles were excavated by hand auger with a 5 cm diameter head to a depth of ~5 cm. Sediment analysis was carried out through soil physicochemical properties and XRD/XRF were done for mineralogy. According to the XRF results, main minerals of quartzite and calcite are observed over the playa. After XRD results, the major minerals in the sediments were categorized as quartzite, halite, calcite, and gypsum. Afterward, the minerals of halite, calcite, gypsum indicate dominant evaporate process. Enrichment of evaporate minerals on the surface grounds are an evidence of a variation hydrostatic level of Sabzevar playa, which can be a signal for a wet lake in the past and dried one in the present day.
Keywords: Sedimentary Records, Mineral Composition, Geomorphology, Sabzevar Playa

1. Introduction

Geomorphological knowledge of the arid and semi-arid regions has greatly improved in recent years. For instance, the sedimentology, topography and geomorphology of shoreline, fluvial and aeolian sediments has been used to investigate dry playa lakes in arid centre of Australia by a broad of authors (DeVogel et al. 2004, Magee et al. 2004, Leon and Cohen 2012, Cohen et al. 2015, May et al. 2015). However, the geomorphologic exploration of dry lake playas' sedimentary data has not been studied extensively due to its multidisciplinary nature. The present study was aimed to investigate the geomorphic process in an arid region using sedimentary records and mineral compositions, which can represent the evidence of regional responses to climate change during the Quaternary period. For this purpose, a dry lake place named as Sabzevar playa was chosen to study in central Iran.

2. Materials and methods

2.1. Study area

Sabzevar dry lake has been categorized as a typical playa in central Iran (Kearey 2009). On this basis, Sabzevar playa, which is located in the eastern great Kavir basin, was chosen as the study area with total surface area of about 2648 Km^2 between latitude 35°55'00"–36°25'00" N and longitude 56°15'00"–57°45'00" E (Fig. 1). The topographical elevation values of the study area vary between 750 and 900 m above sea level (a.s.l). The study area has a semi-arid climate with annual precipitation of 150–200 mm and annual temperature of 16–17 °C in the period of 1950–2000 (Hijmans et al. 2005).

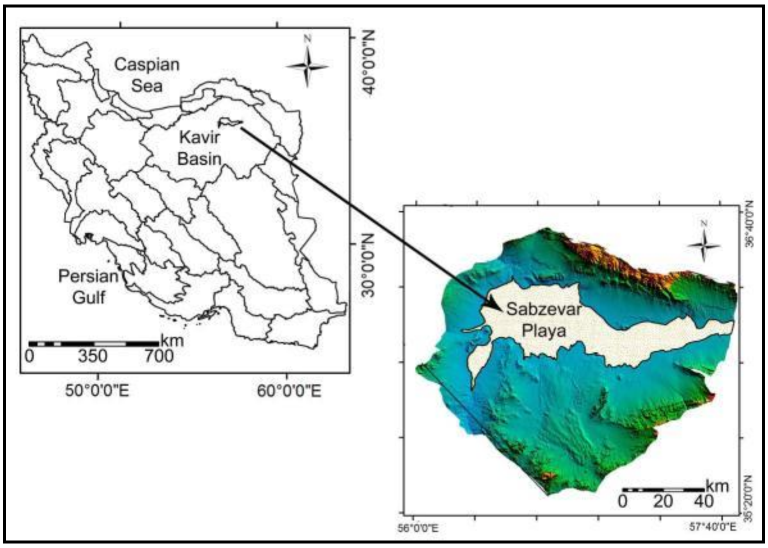

Fig. 1: General position of the study area in great Kavir basin, central Iran

2.3. Methodology

Geological investigation of the study area was based on four sheets at the 1:100,000 scale (GSI 2005). Based on a set of digital elevation model data scaled at ~10 m pixel size topographical elevation data were carried out in ArcGIS (GSI 2016). Sampling profiles were documented at 12 locations on different surfaces. All profiles were excavated by hand auger with a 5 cm diameter head to a depth of ~5 cm. All sampling profiles were measured in the field with regard to texture, chemical precipitates such as gypsum, carbonate, and the occurrence of other sedimentary structures in same way proposed by May et al. (2015). X-ray Fluorescence (XRF) was used to analyze of major element oxides and trace element concentrations after the standard analytical procedures of Kramar (1997). Mineral composition of profiles was determined by X-ray diffraction (XRD) after Sinha (2006). Geochemical composition was determined separately for soil characteristic regarding EC, and pH through various analytical techniques at the laboratory of Natural Resources and Environment College of Ferdowsi University of Mashhad.

3. Result and Discussion

3.1. Physicochemical properties

Based on a set of fieldwork observations during the dry season of 2016 and for sampling soil and depositional records, 12 samples were taken along Playa surfaces including firm puffy ground, clay-carbonate plain, and salty pan with the dominance of Halite salts. The general position of three major geomorphologic landforms and location of profiles was represented in Fig 2 and general vision of aforementioned landforms was seen in Fig. 3. All physiochemical properties of EC, pH, $CaCo_3$, and soil graining analysis are shown in Table 1. According to the Table 1, EC, pH, and $CaCo_3$ contents in profile 207 (as an indicator auger in puffy ground), 286 (as an indicator auger in clay ground), and 290 (as an indicator auger in salt crust) were estimated equal 0.21, 18.40, and 33.66 dS/m, 10.40, 9.23, and 9.13 and 30, 29, and 21 %, respectively. Hence, the surface of variation of EC has a great gradient from puffy ground to salt crusts, while other chemical components have same variations over the playa.

Based on graining analysis, all profiles represented overall sandy texture for playa's soil indicating osmosis penetration of ground waters in sediment surface and formation of puffy or salt crust geomorphology. The large pore spaces in profiles are interfered to create of lenticular structures. Owliaie et al. (2006) and Farpoor et al. (2012) in the playas of Iran have reported a similar mechanism.

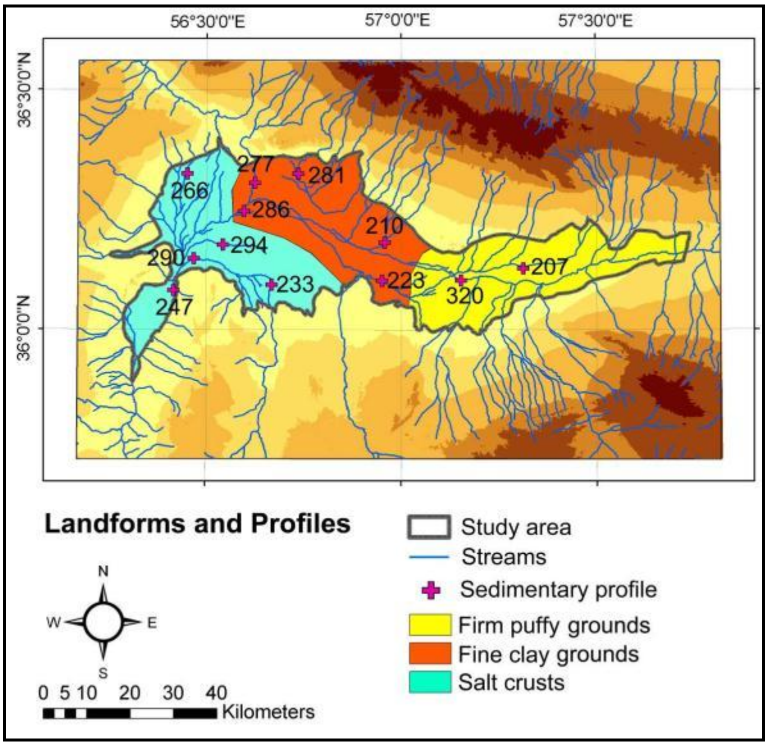

Fig. 2: General position of landforms and location of profiles

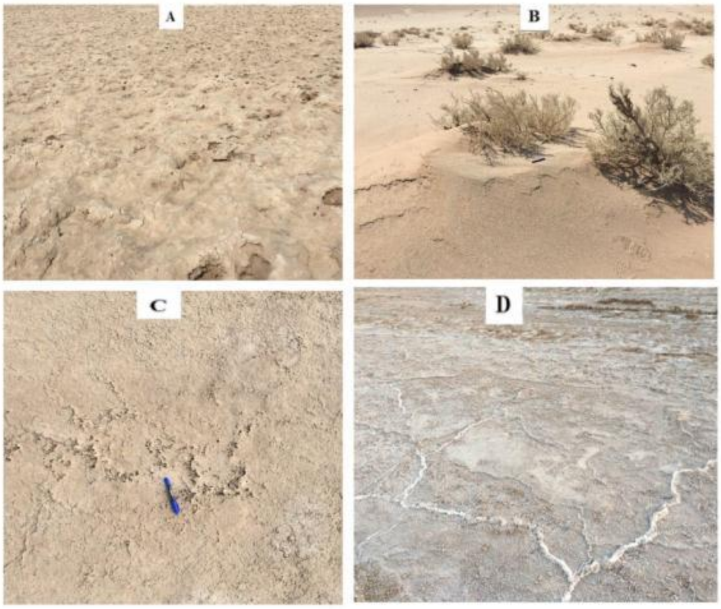

Fig. 3: General vision of landforms consisted of puffy grounds (A), fine clay grounds and embary Nebkha (B), physical carbonate crust (C), and salt crusts, Takir (D)

Table 1: Physiochemical properties of profiles

No.	Profile ID	EC (dS/m)	pH	CCE (%)
1	207	0.21	10.40	30
2	210	4.06	8.45	20
3	223	71.34	7.64	24
4	233	8.85	8.18	28
5	247	37.24	9.39	14
6	266	9.13	9.21	33
7	277	14.14	8.42	28
8	281	30.77	8.17	22
9	286	18.40	9.43	29
10	290	33.66	9.13	21
11	294	23.47	9.25	32
12	320	26.81	8.11	26

3.2. Geochemical properties

Based on the geochemical results of XRF about 12 components were extracted from profiles as shown in Table 2. According to the table 2, the most compositions were demonstrated averagely as SiO_2, Al_2O_3, CaO, and MgO with mean values 42.82, 9.12, 9.07 and 8.68 %, respectively. On this basis, the main mineral of quartzite is observed in whole playa. After XRD results, the major minerals in the sediments were categorized as quartzite, halite, calcite, and gypsum (Table 3). Quartzite as a main clay mineral in modern sediments relates to the climate and weathering pattern of the source area (Rahimpour–Bonab and Abdi 2012). In all profiles, amount of quartzite is seen with mean value of 34%. Afterward, the minerals of halite, calcite, gypsum indicate dominant evaporate process. In this regard, the mean values of mentioned three minerals have been recorded as 27%, 25%, and 20% in the most profiles. The most calcite mineralogy was observed in profile 210 over the fine clay grounds, however, the most gypsum mineralogy was observed in profile 294 over the salt crusts agreeing geomorphologic definition of fieldwork.

Table 2: Chemical compositions of samples by XRF (%)

No.	Profile ID	SiO_2	Al_2O_3	Fe_2O_4	CaO	Na_2O	MgO	K_2O	TiO_3	MnO	P_2O_6	Cl_3	SO_4	LOI
1	207	55.68	10.89	5.77	9.50	1.41	5.33	1.57	0.54	0.10	0.12	0.02	0.01	8.19
2	210	41.88	8.23	5.08	6.29	9.24	9.75	1.66	0.42	0.08	0.10	4.20	3.50	9.56
3	223	40.67	8.16	5.12	7.79	6.70	7.52	1.76	0.43	0.08	0.11	10.50	0.08	10.46
4	233	46.47	9.97	4.98	13.76	1.19	7.29	1.46	0.44	0.08	0.10	0.10	2.80	10.64
5	247	40.52	8.48	5.92	7.90	5.95	8.84	1.92	0.50	0.09	0.12	4.90	4.80	9.31
6	266	41.00	11.69	6.67	12.20	1.86	6.33	2.53	0.59	0.10	0.16	1.01	0.65	14.42
7	277	41.22	9.57	6.72	7.69	6.45	7.97	2.10	0.47	0.10	0.12	5.90	2.60	9.05
8	281	30.55	6.76	5.25	12.06	3.05	10.37	1.26	0.43	0.09	0.13	2.30	10.30	16.77
9	286	43.67	8.82	6.35	7.67	5.82	9.38	1.79	0.49	0.10	0.11	5.30	0.30	9.61
10	290	45.53	9.92	6.57	8.63	4.39	8.53	2.07	0.53	0.11	0.12	3.80	0.06	9.22
11	294	43.65	7.64	7.77	6.95	1.23	15.64	1.52	0.50	0.12	0.11	0.70	1.80	12.10
12	320	43.04	9.37	5.67	8.41	7.34	7.28	1.84	0.45	0.09	0.11	6.90	1.30	8.10

Table 3: Mineralogy of profiles by XRD (%)

No.	Profile ID	Halite	Quartzite	Zeolite	Gypsum	Albite	Calcite	Montmorillonite	Cristobalite	Palygorskite	Muscovite	Dolomite	Fe_2O_3
1	207		35.8			42	11.6					9.8	
2	210	21.8	36.3				41.9						
3	223	44.2	27.9			0.5	22.9						
4	233		72.4				21.7						5.7
5	247	19.8	17		27.8						35.4		
6	266		43.6			3.4	39		3.2	10.8			
7	277	18.8	21.5		6.5		23.3			26.4	3.5		
8	281	11.1	43.7		13	17.2	15						
9	286	40.8	28				21			10.1			
10	290	24.6	38.5				26			10.9			
11	294		14.8	18.8	44			21					
12	320	39.4	22.2		10.2		28.2						

4. Conclusion

All physiochemical properties of EC, pH, $CaCo_3$, and soil graining analysis was investigated through profiles. On this basis, high concentrations of EC (>48 dS/m), $CaCo_3$ (>27 %), and pH (>9) are observed in southern, eastern and western playa's grounds. Aforementioned consequence is corresponded to detect of playa's three major geomorphologic landforms in fieldwork observation. According to XRF, the main minerals of quartzite and calcite are observed in whole playa. After XRD results, the major minerals in the sediments were categorized as quartzite, halite, calcite, and gypsum. Afterward, the minerals of halite, calcite, gypsum indicate dominant evaporate process. In this regard, the mean values of mentioned three minerals have been recorded as 27%, 25% and 20% in the most profiles. As well as, It seems a modern deposition pattern of carbonates and chloride in eastern and western parts of the playa, respectively. Nevertheless, central playa shows the grounds without alkaline condition and carbonate deposition because marginal wind-borne deposits and sand dunes have affected it dominantly. Enrichment of evaporate minerals on the surface grounds are an evidence of a variation hydrostatic level of Sabzevar playa, which can be a signal for a wet lake in the past and dried one in the present day.

References

Cohen TJ, Jansen JD, Gliganic LA, Larsen JR, Nanson GC, May JH, Jones BG, Price DM, (2015). Hydrological transformation coincided with megafaunalextinction in central Australia. Geology, 43: 195–198.

DeVogel SB, Magee JW, Manley WF, Miller GH (2004). A GIS–based reconstruction of Late Quaternary paleohydrology: Lake Eyre, arid central Australia. Palaeogeogr. Palaeoclimatol. Palaeoecol, 204: 1–13.

Farpoor MH, Neyestani M, Eghbal MK, Borujeni IE (2012). Soil–geomorphology relationships in Sirjan playa, south central Iran. Geomorphology, 138: 223–230.

Geological Survey of Iran (2005). Geological sheets of 7262 (Abbas–Abad), 7362 (Davarzan), 7462 (Bashtin), and 7562 (Sabzevar), Scale 1:100,000.

Geological Survey of Iran (2016). Digital elevation model data, Scaled at ~10 m pixel size.

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005). Very High Resolution Interpolated Climate Surfaces for Global Land Areas. International Journal of Climatology, 25(15):1965–1978

Kearey P (2009). The Encyclopedia of the Solid Earth Sciences. John Wiley & Sons, pp 736.

Kramar U (1997). Advances in energy–dispersive X–ray fluorescence. Journal of Geochemical Exploration, 58: 73–80.

Leon JX, Cohen TJ (2012). An improved bathymetric model for the modern and palaeo Lake Eyre. Geomorphology, 173–174: 69–79.

Magee JW, Miller GH, Spooner NA, Questiaux D (2004). Continuous 150 k.y. monsoon record from Lake Eyre, Australia: insolation–forcing implications and unexpected Holocene failure. Geology, 32: 885–888.

May JH, Barrett A, Cohen TJ, Jones BG, Price D, Gliganic LA (2015). Late Quaternary evolution of a playa margin at Lake Frome, South Australia. Journal of Arid Environments, 122: 93–108.

Owliaie HR, Abtahi A, Heck RJ (2006). Pedogenesis and clay mineralogical investigation of soils formed on gypsiferous and calcareous materials on a transect, Southwestern Iran. Geoderma 134: 62–81.

Rahimpour–Bonab H, Abdi L (2012). Sedimentology and origin of Meyghan lake/playa deposits in Sanandaj–Sirjan zone, Iran. Carbonates Evaporites, 27:375–393.

Sinha R, Smykatz–Kloss W, Stüben D, Harrison SP, Berner Z, Kramar U (2006). Late Quaternary palaeoclimatic reconstruction from the lacustrine sediments of the