Geochemistry and uranium quantity study of the alluvium sediment in south-eastern Mashhad plain

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Abstract
In order to consideration and detection of Uranium from quaternary Mashhad South-Eastern Plain sediments, a numbers of river sediment samples from that area was prepared using XRF diffraction. The resulted data were calculated by statistical studies using SPSS16 and Spearman software's. Hereby the statistical studies appointed that the Uranium correlations in the ore deposit sediment samples mostly is close to elements of Y (Yttrium), ***Rb(Rubidium)*** *and Sr (Strontium). Throughout the abundance of Uranium on quaternary Mashhad south-eastern plain sediments is low range. One of the rational reasons for lowing rang of Uranium in Mashhad south-eastern plain is attributed to short path of the channels, rivers or playas which is decreases the geochemaical and hydrogeochemical activities of them.*

Key words: *surficial uranium, south-eastern Mashhad plain, sediment geochemistry, granitoid*

1. Introduction
In recent years, uranium is considered as one of the most important energetic minerals in the world (Wu, 2010). Most part of this mineral is used to elicit the energy and a small part is used to produce important medical isotopes. Uranium as a natural component is chemically poisoning and belongs to heavy and radioactive metal family. Natural uranium has +3, +4, +5 and +6 oxidation states for which UO_2^{2+} and UO_2 $(OH)_2$ are in stable and unstable forms, respectively (Domingo, 2001). In some area, the discovered uranium was accompanied by copper (Zhai, 1996). For example, we can point to Olympic Dam in Australia. The mine currently operates by an underground mining method called sublevel open stopping, using modern and highly productive mining equipment. The March 2005 mine production rate is an annualized 9.1 million tones making it one of Australia's larger mines. 2005 metal production is thought to be in excess of 220,000 tones of copper, 4500 tones of uranium oxide, plus gold and silver (world nuclear news, 2008). Sometimes in some mining operations like gold mining, for example in South Africa, it is found as by- product. In such cases, uranium's density is less than 0.1 of its primary amount in the mine. We can categorize the distribution of the uranium, in the world, on the basis of their geological conditions into 14 main groups. One of them is surficial uranium which will be discussed in this article (OECD-NEA/IAEA

2006). One of the primary sources of uranium is acidic igneous rocks and stones. During long history of geology, uranium has geochemically influenced the sediments of elements belong to its sub group from inside of washed stones and because of concentration (Hassani Pak, 1983). Concentrated uranium, in chemical atmosphere of semi-arid river areas, sticks the sediments in secondary cement form known as Surficial Uranium or Calcrete (Otton, 1984). Calcretes' uranium is accompanied with other elements which are categorized on the basis of their geochemistry. These divisions include Uranium (+6) - like Uranyl Vanadates, Uranyl Phosphates, Uranyl Silicates and alkalis like uranium hydroxides U-V-Pb (Hydroxides) – and Uranium (+4) (Otton, 1984). In this research, the southeast plain of Mashhad was investigated to determine the percentage of existent uranium of the region. Of the important reasons to assume the formation of uranium compounds in the sediments of recent era are its location in domains of granites in Mashhad, semi-dry climates and its geological similarity with most important field of surficial uranium concentration in the world. In order to review this assumption, the sediments of Mashhad plain rivers, Ziyaratgah, Khajeh Moraad, Bidak and Gheshlaagh River were selected for sampling. The findings of the research as well as statistical calculations (Pagel, 1984), the geological sediments of recent era were determined and then the elements such as Sr, Rb and Y have been identified with the highest level of meaningfully with U element.

2. Geographical setting

It is located in the south east of Mashhad in Khorasan Razavi province between 59 degrees and 42 minutes to 59 degrees and 45 minutes of longitude. This plain is limited to Mashhad from north, to Kashafrood river basins from east and to granite highlands of Mashhad from west and south. The most important and the best way to have access to the region is Neishabour road. The investigated region begins from Khajeh Moraad tomb at the west and spreads to Gheshlaagh village at south and reaches to Mashhad-Neishabour road from north and east.

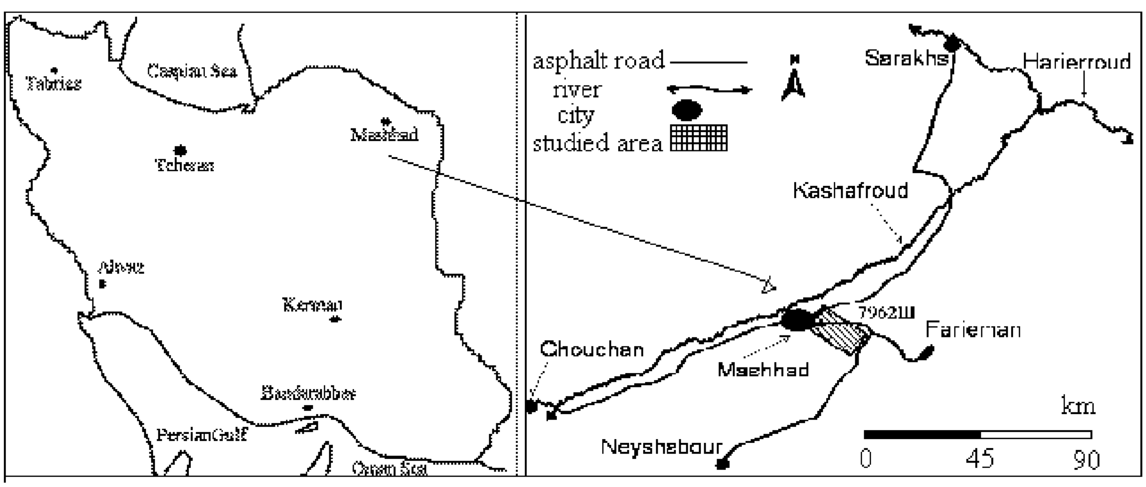

Figure 1. Geographical Situation of the studied area. Interconnection roads and Kashafroud and Harierroud rivers, modified from the 1:50000 map geographical organization, No.7962-III

3. Geologic setting

The geological position of south east plain of Mashhad is mostly affected by Mashhad's granitoids and quaternary alluvial sediments. These sediments cover the plains and glen's bases and are almost without any categorization. In domains of south highlands, alluvial sediments of Mashhad plain are relatively in big particle forms and their maximum thickness is 250 meters. Most of regional alluvia have turned into agricultural lands, since the high amount of stones and fresh water. Other segments of plain have been used for residential and industrial constructions. Within the Binaloud highlands in the west and south of Mashhad, which has been the result of north section of paloetethys closure, it is like a long and thin belt which is expanded towards northwest and southeast (Homam 2006, Karimpour et al. 2006). The lower cretaceous of conglomerate unit and Orbitolina limestone unit of lower cretaceous have been called as conglomerate of cretaceous and limestone of cretaceous, respectively (Taheri & Ghasemi, 1996). The lower cretaceous of conglomerate unit comprises conglomerate and sandstone with brown to light gray colors and is placed on the Jurassic conglomerate and slate collection, schist, marble, conglomerate, carbonate changed conglomerate, lapilli, changed tuff and a low amount of quartzite, chert and volcanically lava of ophiolitic belt with low changing (Rutner, 1993). The existent sands in conglomerate and the particles which create sand are mostly originated from meta-granitoids.

Mashhad's granitoids mass is the source stone of uranium in quaternary sediments of its south east plain. The north east margins of this mass have contact with low degree schists and in some area with quaternary alluvial traces, but in south marginal area, it is limited by a land fault (Dakhili, 1991). These masses with various compounds have been created during three temperature activities from Triassic to cretaceous periods (Karimpour et al., 2006).

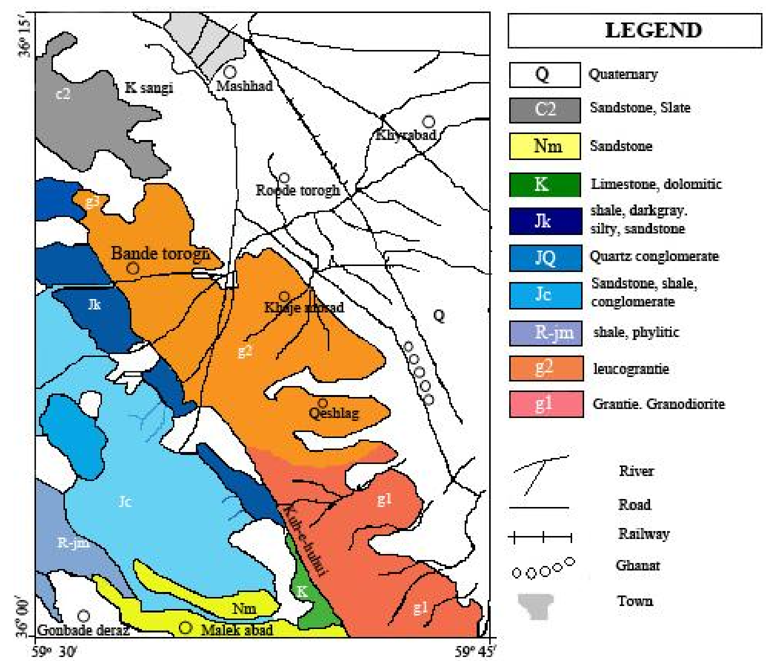

Figure 2. Geologic map of the studied area, adapted from the 1:100000 geological map of Mashhad (Taheri & Ghasemi 1996).

4.Relationship between the Mashhad area and the other similar areas an viewpoint of geology and surficial uranium

Australia has the greatest reserve of uranium in the world, nearly 30%, with low mining cost (Lambert et al., 2005). Other countries that have noticeable amount of uranium are: Kazakhstan (second rank), Canada (Jones, 1990), South Africa, Namibia, Brazil, Russia and USA. At 1/1/2006 (OECS-NEA/IAEA 2006), the price of per kilo of uranium was 130 dollars (Cavanery, 1984). Australia has produced 1558000 tons uranium in august 2007, as well as increase in the amount of other countries' production (Zukerman, 2006). In west of Australia, those sections with calcrete uranium have been located in valleys filled with sediments throughout the drainage canals of Tertiary and in sediments of Playa lake (Mann & Deutscher, 1978). These masses are located on the green stone of north section of Yilgarn Craton. Due the fact that this region is adjacent to granite masses and other suitable conditions, Uranium mine has been created (Jones 1990, Johnson et al., 1987).

5.Discussion about the surficial uranium deposits in Mashhad plain

In order to evaluate the region and liability of surficial uranium formation, 13 soil samples, about 1 kg, was extracted from 30 cm deep below the 3 seasonal rivers' bases and with 1000 meters intervals (table 1).

Table 1. Sample names and the congruity

Congruity	Sample name
Khajeh Moraad river	KH-1
	KH-2
	KH-3
Bidak river	BI-1
	BI-2
	BI-3
	BI-4
	BI-5
Gheshlaagh river	GH-1
	GH-2
	GH-3
	GH-4
	GH-5

Soil and stone samples were smashed into 0.06 mm (by use of mesh no. 200) and de-composited at element level, with XRF method, in laboratory of the geological survey of Iran, northeast presidency section (Khorasan). In this analysis, in order to study the inter elements correlation, besides determining the uranium density, the density of 17 elements and 10 other compounds, by using XRF method, was achieved (tables 2 and 3).

Then, SPSS 16 and Excel software were applied to draw frequency curves, convergence and the table of correlation coefficient.

Table 2. Composition percent amount of sample analaysis

Sample name	Composition								
	P_2O_5	TiO_2	K_2O	MgO	Na_2O	CaO	Fe_2O_3	Al_2O_3	SiO_2
KH-1	0.337	0.51	3.13	2.16	1.97	2.77	3.84	14.88	66.02
KH-2	0.28	0.44	3.05	2.13	2.19	2.70	3.46	14.14	66.97
KH-3	0.29	0.33	3.11	1.31	2.57	3.53	2.53	13.96	68.84
BI-1	0.11	0.37	2.93	0.99	2.03	4.35	3.15	12.57	68.93
BI-2	0.10	0.31	2.87	0.90	1.93	4.24	3.22	12.56	68.98
BI-3	0.11	0.30	2.88	0.84	2.09	4.03	2.80	12.24	71.21
BI-4	0.90	0.27	3.00	0.73	2.24	3.98	2.42	1244	71.77
BI-5	0.11	0.33	2.88	0.90	2.09	4.38	2.91	12.25	70.50
GH-1	0.19	0.48	2.55	1.33	3.17	7.10	3.94	13.22	63.21
GH-2	0.17	0.41	2.66	1.15	3.36	6.54	2.92	13.36	65.67
GH-3	0.13	0.32	2.80	1.08	3.53	6.34	2.58	13.95	64.98
GH-4	0.20	0.44	2.66	1.14	2.91	6.53	3.48	13.02	65.88
GH-5	0.13	0.29	2.88	0.84	3.25	5.41	2.27	13.60	68.63

Table 3. P.P.M. Amount of elements result from the sample analysis

Sample name		**KH-1**	**KH-2**	**KH-3**	**BI-1**	**BI-2**	**BI-3**	**BI-4**	**BI-5**	**GH-1**	**GH-2**	**GH-3**	**GH-4**	**GH-5**
Elements	**L.O.I%**	4.03	4.02	3.63	3.62	3.20	3.19	3.04	3.20	3.71	3.56	4.17	3.45	2.94
	U	9	7	5	6	2	1	1	N	4	4	N	2	N
	La	72	49	52	42	N	23	15	42	103	80	48	93	42
	Sb	N	N	1	N	2	N	N	2	N	N	N	4	N
	Mo	6	3	4	3	4	4	4	3	4	4	4	3	5
	Zn	129	99	106	68	63	69	47	63	133	57	53	58	48
	Zr	201	154	142	123	108	126	117	136	245	199	152	213	144
	Y	30	28	27	20	19	18	18	19	20	19	17	20	18
	W	N	300	402	437	N	N	463	397	N	263	6	220	3
	V	72	62	47	50	45	47	39	46	64	52	44	56	41
	Sr	277	295	353	414	403	415	417	403	803	856	825	717	792
	Rb	212	193	199	100	95	107	105	102	89	94	99	99	104
	Ni	41	43	30	23	16	25	13	19	15	11	9	17	15
	Nb	41	29	30	14	13	13	12	14	54	47	34	51	35
	Cu	27	22	22	16	21	23	28	22	208	24	21	40	32
	Cr	145	29	8	16	147	156	7	16	124	8	129	23	97
	Co	12	23	28	29	2	5	27	27	4	20	9	18	7
	Ce	191	61	75	11	61	64	66	70	196	147	68	120	65
	S	N	N	N	17	N	N	N	N	N	N	N	N	N
	Cl	282	281	227	265	190	156	139	145	168	113	178	203	161

- N: no detection
- L.O.I.: Lost Of Ignition

6. Conclusion

Mashhad's south east plain from petrological, mineralogy of source stone (granitoids), quaternary sediments of base stone (ultra basic collection) and hydro-geochemical conditions of underground and surface water of the region, is likely to form calcretes and surficial uranium compounds. Mashhad's granitoids, especially pegmatite of Khajeh Moraad, because of the high amount of alkali elements such as potassium and rapid separation of these single density elements at the beginning phase of mineral hydrolyzing, make the regional quaternary completely ready for forming the surficial uranium compounds. This element along with elements such as Sr, Y and Rb, have the highest percentage of availability and meaningfulness. Within these three elements, Y element is more likely to contain the uranium indicator. The low amount of density in uranium source stone with the maximum of nine ppm in Khajeh Moraad's pegmatite has caused that uranium does not concentrate in south east of Mashhad, at the rate in which surficial mines are created.

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