Exploration and Environmental Significance of Heavy Elements in Plants and soils in Urban Areas of Kerman City

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Abstract:

The investigation on the environmental geochemistry of plants and soils has been carried out in an area of 620 km^2 in the urban areas of Kerman city. About 46 samples of tree leaves and plants were collected by systematic random sampling method, were prepared and analyzed by ICP-OES and AAS methods in Geological Survey of Iran. Geochemical data show that Cu contents in leaf of tamarisk, alfalfa plant and licorice root and leaf are 129.5, 109.28, 100.84 and 100.42 mg kg^{-1}, respectively. The mean Mo values in pistachio leaf and alfalfa plant follow 14.85 and18.68 mg kg^{-1} and Pb contents in pistachio and licorice leaf are 18.92 and 6.19 mg kg^{-1}, respectively. The Zn concentrations in leaves of tamarisk, licorice and alfalfa are 424.38, 295.8 and 283.8 mg kg^{-1}. The chromium values are 10.36 mg kg^{-1} and 43.89 mg kg-^{1} in leaves of elm and licorice. The nickel contents are 13.9, 37.8 and 38.3 mg kg^{-1} in pistachio and licorice leaves and root. Vanadium values are 10.28 mg kg^{-1} in the elm leaf. The average values of Sr are variable between 325.90 mg kg^{-1} in aspic leaf to 1922 mg kg^{-1} in cypress tree. The mean arsenic contents include 76.7 mg kg^{-1} in leaf of tamarisk trees, 23.6 mg kg^{-1} in licorice leaf and 12.4 mg kg^{-1} in licorice roots. The correlation coefficient in soil and plant and bioaccumulation index may indicate the dispersion of elements from the soil to the plants. Geochemical maps show higher Cu values in the metropolitan areas, Mo contents in the urban areas of Kerman city, Pb values in the Kerman international airport, Zn contents in the northern parts of the area and Cr and Ni values in the northwestern part of Kerman city are noteworthy.

Keywords: Geochemistry; Heavy metals and toxic elements; Plants; Urban areas of Kerman city.

1- INTRODUCTION

The geochemical distribution of heavy metals and toxic elements in plant and roots has significant roles in exploration and environmental studies (Chambers, 2016, Kleckerova and Docekalova, 2014; Viehweger, 2014; Ashraf et al., 2011 Kuramshina et al., 2014). There exist numerous data on the biogeochemical cycles of elements on plants in urban areas (Anicic et al, 2011; Tomasevic et al., 2013; Wang, 2012; Naziri et al., 2015). However, less attention have been given to the biogeochemical investigations in Iran expect few cases, reported by Ghaderian and Ghotbi Ravandi, 2012 for Cu, Pb, Zn and Ni in 146 plant species in the Sarcheshmeh mines. Also, Parizanganeh et al., (2010), reported some heavy metals on top soils and plants in Zanjan Zinc Industrial town, Iran. This investigation highlights on the first geochemical data of plants in the urban areas of the Kerman city.

2- METHODS

About 500 grams of 46 samples of tree leaves (pistachio, tamarisk, elm, aspic, buckthorn, apricot and pomegranate) and plants (alfalfa, licorice, wheat and barley) were collected by systematic random sampling method. The samples were washed with distilled water, dried and after ashing were analyzed by ICP-OES and AAS methods for 52 elements in the laboratories of Geological Survey, Karaj center, Iran.

3- FINDINGS AND ARGUMENT

It is wel known that the heavy metals and toxic elements in rocks and soils could diffuse into the plants, which give environmental as well a exploration signatures. The comparison of the mean values for heavy metals and toxic elements in plant samples of the urban areas of Kerman city are within the safeguard level, thus, no contamination or exploration signature has yet been detected. The geochemical plants data from the urban areas of the Kerman city highlight that the highest values of lead (19.6 mg kg^{-1}), nickel (38.3 mg kg^{-1}), chromium (43.89 mg kg^{-1}), strontium (2040.7 mg kg^{-1}) and vanadium (73.21 mg kg^{-1}) in licorice plants are notable. The high values of copper (138.7 mg kg^{-1}), strontium (2404.6 mg kg^{-1}) and molybdenum (31.8 mg kg^{-1}) were found in leek and mint vegetables as well as alfalfa (Table.1). The bioaccumulation index of elements, histograms and cumulative percentage diagrams indicate a weak diffusion from soil to plants for the elements (Fig.1).

Table 1. Minimum, maximum, average and standard deviation of heavy metals in plant samples in the urban areas of the Kerman city.

Type (samples)	values	Cu	Mo	Pb	Zn	Cr	Ni	V	Sr	Ba	As
Cypress tree leaf (2)	Min	28.70	3.65	4.72	142.87	7.22	5.0	5.60	535.76	26.57	7.50
	Max	47.08	3.65	8.90	171.51	9.59	6.5	6.50	3309.8	33.59	7.50
	Average	37.89	3.65	6.81	157.19	8.41	5.8	6.05	1922.8	30.08	7.50
	Sd	13.00	---	2.96	20.25	1.67	1.08	0.64	1961.5	4.97	---
Tamarisk tree leaf (12)	Min	59.25	1.05	3.44	158.98	3.12	4.6	2.60	301.57	14.95	7.50
	Max	129.50	5.34	15.15	424.38	9.97	15.1	10.28	3417.7	82.70	10.60
	Average	100.84	2.46	8.26	272.01	5.87	7.1	4.95	1136.0	38.83	7.76
	Sd	22.60	1.51	3.40	85.42	2.24	2.88	2.15	812.96	21.00	0.89
Buckthorn tree leaf (2)	Min	48.24	3.29	0.75	265.88	4.21	13.5	1.86	603.97	8.34	7.50
	Max	104.01	3.29	2.36	290.84	6.03	21.2	3.81	1147.5	28.08	7.50
	Average	76.13	3.29	1.56	278.36	5.12	17.3	2.84	875.74	18.21	7.50
	Sd	39.44	---	1.14	17.65	1.28	5.44	1.38	384.34	13.95	---
Apricot tree leaf (1)	Average	95.75	5.89	7.81	261.32	2.82	5.8	2.42	944.01	25.15	7.50
Pomegranate tree leaf (1)	Average	136.84	2.92	3.20	219.21	2.79	3.8	2.41	1133.1	29.78	7.50
Pistachio tree leaf (13)	Min	35.64	1.06	1.17	170.87	1.37	2.8	1.02	270.97	8.30	7.50
	Max	72.62	14.85	18.92	369.67	7.47	13.9	2.50	1743.1	35.19	7.50
	Average	58.33	5.74	6.14	245.17	3.82	6.2	1.87	714.32	18.44	7.50
	Sd	11.05	7.89	4.69	63.84	2.27	3.48	0.48	523.25	8.64	---
Aspic tree leaf (1)	Average	104.94	2	1.59	268.27	1.49	15.1	1.07	598.94	8.05	---
Elm tree leaf (1)	Average	68.36	1.21	4.61	238.41	10.36	11.6	9.78	1981.1	63.9	7.50
Wheat leaf (4)	Min	85.48	1.44	2.49	137.28	1.06	3.2	4.91	680.00	29.84	7.50
	Max	98.35	13.10	4.87	206.98	16.09	9.0	1.48	325.90	15.83	7.50
	Average	92.58	9.83	3.62	157.74	7.58	5.3	1.18	260.44	43.24	7.50
	Sd	5.47	5.63	1.26	32.95	6.27	2.67	5.46	529.68	89.48	14.78
Barley leaf (1)	Average	67.51	9.06	7.13	194.39	11.72	7.4	3.11	369.04	59.84	11.07
Alfalfa leaf (1)	Min	96.90	7.93	4.02	192.05	2.13	6.8	1.95	126.10	20.67	4.12
	Max	127.26	31.82	14.05	383.57	6.29	12.6	1.58	271.86	30.16	7.50
	Average	109.28	18.63	7.12	283.85	3.79	9.3	1.36	1772.2	26.55	7.50
	Sd	13.14	12.19	4.67	82.65	1.94	2.78	5.44	2776.9	50.48	7.50
Leek leaf (1)	Average	138.7	2.85	10.20	381.2	7.15	7.36	10.54	1557.6	58.22	< 10
Mint leaf (1)	Average	95.9	3.06	8.67	231.7	11.57	10.19	9.02	2404.6	69.61	< 10
Licorice leaf (1)	Average	100.42	1.22	19.06	295.80	43.89	37.8	73.21	648.22	204.5	23.66
Licorice root (1)	Average	100.84	9.03	8.24	200.63	43.62	38.3	31.84	2040.7	106.6	12.38

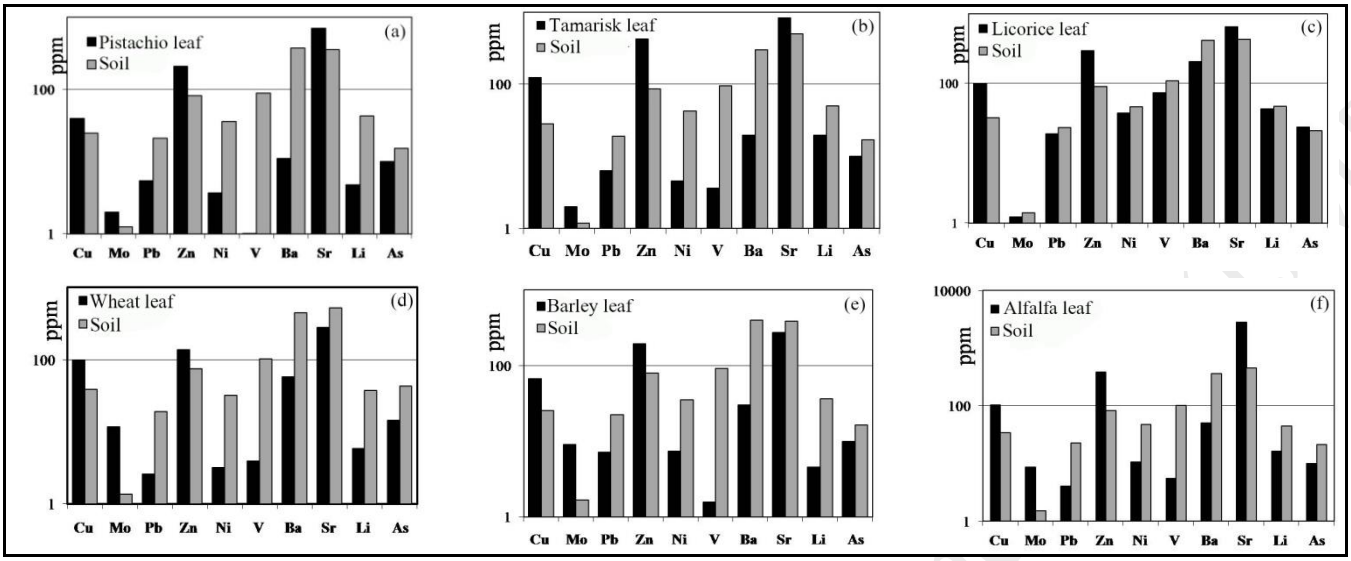

Fig.1. Heavy metal contents in the leaf of pistachio and tamarisk trees, licorice, wheat, barley and alfalfa leaf plants in the urban areas of the Kerman city.

4- CONCLUSIONS

1. High contents of molybdenum are detected in pistachio leaves (14.85 mg kg^{-1}) and alfalfa (31.82 mg kg^{-1}). The highest value of zinc has been concentrated in leaves of tamarisk (424.4 mg kg^{-1}).

2. High values of chromium (43.9 mg kg^{-1}), nickel (37.8 mg kg^{-1}), vanadium (73.2 mg kg^{-1}) and barium (204.5 mg kg^{-1}) have been detected in licorice plant.

3. The amount of strontium in plants is much higher than the global average, which is related to the carbonate rocks in the urban areas of Kerman city.

4. The relationship between metal abundances in soil and plant indicate a poor reaction between soil and plant species.

5. So far, the biogeochemical data on heavy metals and toxic elements in plant samples do not show any trigger risk in the leaves of trees and vegetables in the urban areas of the Kerman city, nor a significant exploration guide

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