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Using Various Tree's Leaves in Prospection of the Auriferous Quartz Veins and Sulphide Lodes (Hatay-Southern Turkey)

Çeşitli Bitki Yapraklarının Altın İçeren Kuvars ve Sülfît Damarlarının Prospeksiyonunda Kullanılması

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Abstract

This investigation is concerned with the effect of mineral content of soil to the tree leaves in Kisecik village and its surroundings located 11 km NW of the city of Hatay.

The leaves of Planatus oriantalis. Arbutus andrachne, Alnus glutinosa, Salix alba, Cistus creticus, Philyrea latifolia, Pistacia lentiscus, Quercus infectoria and Quercus coccifera were chosen for the study and 50 elements were analysed for 23 samples in the study area.

The average values of the As, Zn, S, Au, Ag, Cd, Co, P, Na, K, Sb, Se, Y, Mn, Gd and Nd were determined to be higher in the leaves of the trees having direct contacts with the auriferous quartz veins and sulphide lodes.

On the other hand, the mentioned trees in the ultramafic area away from the auriferous quartz veins and sulphide lodes were found to be enriched in Mg, Ni, Fe, Mo, Cr, B, Sr, Ca, Ba, Al, Bi, Pr and Ce.

The mean value of the Te, Ga, Sm and Dy were detected almost the same in the trees in the both area.

Finally, U, Th, V, La, Ti, W, Tl, Ho, Tb, Er, Tm, Yb and Lu values of the leaves could not have been determined due to the low level of these elements.

As a results, some of the trees such as Cistus creticus and Salix alba were noticed to be the most sensitive trees affected by the soil. Pb, Ni, Co, Mn, Fe, Cd, Bi, P, Cr, Al, Na, Ga, Y, Ce, Pr, Nd, Sm, Gd and Dy content of Cistus creticus is higher than the rest. On the other hand Salix alba is higher in Mo, Zn, Ca, Mg, Se, S (in mining area) and Co, Mn and Cd (in non-mining area).

This result suggests that leaves can be used as indicator for the auriferous quartz veins and sulphide lodes.

Key Words : Geobotanic, gold, silver, leaves

Öz

Hatay ili merkezine 11 km uzaklıkta bulunan Kisecik köyü ve çevresinde, altın ve gümüş içeren kuvars ve sülfıt damarlarının bulunduğu bölgede, Çınar, Sandal, Kızılağaç,Söğüt,Pürem, Sakızlık.Çitlembik, Karapelit ve Pelit gibi 9 bitki türünden 23 yaprak örneği alınarak 50 element üzerinde yapılan çalışmada, bitkilerin, bulundukları bölgeden etkilenme dereceleri araştırılmıştır (Şekil 1).

Altın içeren sülfit ve kuvars damarları ile doğrudan temasta bulunan ağaç yapraklarındaki ortalama As, Zn, S, Au, Ag, Cd, Co, P, Na, K, Sb, Se, Y, Mn, Gd ve Nd değerlerinin ,yüksek olduğu belirlenmiştir. Diğer taraftan, Bu damarlardan uzakta ve ultrabazik.bazik kayaçların üzerinde yetişen aynı bitkilerin yapraklarının Mg, Ni, Fe, Mo, Cr, B, Sr, Ca, Ba, Al, Bi ve Ce bakımından zenginleştiği belirlenmiştir. Yapraklardaki Te,Ga, Sm ve Dy değerlerinin ise her iki bölgede aynı değerlerde kaldığı ve U, Th, V, La, Ti, W, Tl, Ho, Tb, Er, Tm, Yb, ve Lu değerlerinin ise .miktarlarının çok düşük olması sebebiyle belirlemediği görülmüştür.

Sonuç olarak Pürem ve Söğüt'ün bulunduğu ortamdan en çok etkilenen bitkiler olduğu belirlenmiştir. Pb, Co, Mn, Fe, Cd, Bi, P, Cr, Al, Na, Ga, Y, Ce, Pr, Nd, Sm, Gd ve Dy miktarının Pürem bitkisinde .diğerlerine oranla daha fazla olduğu, bunun yanısıra Mo, Zn, Ca, Mg ve Se'un damarların bulunduğu bölgede, Co, Mn, ve Cd'un kayaçların bulunduğu bölgedeki Söğüt ağaçlarında zenginleştiği belirlenmiştir.

Sonuç olarak, yaprakların, altın içeren altınlı kuvars damarları ile sülfıt damarlarının yerlerinin belirlenmesinde bir belirteç olarak kullanılabileceği düşünülmektedir.

***Anahtar Kelimeler:** Jeobotanik, altın, gümüş, ağaç yaprakları*

INTRODUCTION

As it has been pointed out earlier, plants can be used either as geobotanical indicators which reveal mineral anomalies by their presence or absence "Cannon (I960), Viktorov and others (1964), Malyuga (1964), Brooks (1972), Girling and others (1979)" in prospecting for economically important minerals.

This paper reports the results of a biochemical investigation for gold bearing sulphide mineralization in an area of 25 sq. km around Kisecik village, city of Hatay, Turkey.

Plant gold concentration usually occur in the ppb range on a dry weight basis, even in anomalous areas (Jones, 1970). This makes analysis of a plant material for gold difficult and explains why the use of plants as indicators of gold mineralization has not been commonly considered.

The geochemical relationship between gold and arsenic in epitermal deposits has been established by various workers "Boyle and Jonasson (1973), Girling and others (1978), Warren and others (1964), Erdman and Olson (1985)".

In this study the potential use of arsenic and 48 other elements as a pathfinder for gold in this area were examined. Furthermore, the geochemical analyses of the host rocks were examined also to study the effect of chemical composition of the rocks-soil to the studied trees.

LOCATION AND GEOLOGY OF THE STUDY AREA

The study area is located 11 km NW of the city Hatay in Southern Turkey.

The general geology has been described by various authors and as well as by the present author. One area that has received considerable attention is the Kızıldag Ophiolitic complex in the Southern Turkey. Erickson (1940), Wijkerslooth (1942), Romieux (1942), Dubertret (1953), Molly (1955), Vuagnat and Çoğulu (1967), Aslaner (1973), Çoğulu (1973), (1974), Delaloye and others (1980), Selçuk (1981), Alpan (1985), Tekeli and Erendil (1986), Aydal (1989), Pişkin and others (1990) and Çağatay and others (1991) are some to be mentioned.

These workers identified six different rock units within the ophiolitic complex; tectonites, poikilitic zone, cumulates (ultramafic and mafic types), diabase dykes (as a sheeted complex), pillow lavas and volcano sedimentary rocks.

At the present study area the predominant rocks are mainly sheeted diabasic dykes, tectonites, gabbros and pillow lavas are in lesser amount.

Especially diabasic dykes and gabbros are cut by numerous auriferous sulphide lodes and quartz veins, most of which have considerable amount of microdimentional gold and silver. The mineralised zone lies between 450 and 650 meters elevation. Arsenopyrite, sphalerite, chalcopyrite and pyrite are the most abundant sulphide minerals in quartz veins and lodes.

PLANTS SPECIES AND SAMPLING PROCEDURE

Nine species were chosen and 15 samples were collected from the study area. Besides, 8 additional samples were collected from an adjacent area in order to examine the variation of especially As, Zn, Cu, Fe and as well as Au and Ag concentrations in the study area. The last 8 samples were collected from a comparable topographic area nearby, where earlier geochemical studies indicated absence of gold anomalies.

The species collected from the lower area were *Planatus oriantalis, Arbutus andrachne, Alnus glutinosa and Salix alba,* the deep rooted perennials. On the other hand, relatively shallow rooted *Philyrea latifolia, Pistacia lentiscus, Quercus infectoria, Quercus coccifera and Cistus creticus* were collected from the relatively higher elevation at the study area.

All of the species are reasonable widespread not only in the study area but also in Southern and Western part of Turkey. In the mineralised area plant samplings were carried out especially over areas of silicified argillite and sulphide veins and from the plants on the diabase dykes, gabbros and tectonites in non-mineralised area.

Because of the soil contamination root samples were not preferred and approximately 100 gr of leaf samples were collected from each species. The samples were washed and dead material were removed prior of oven drying at 80°-100°C for 12-24 hours depending up on the leaf thicknesses.

ANALYTICAL PROCEDURE AND GEOCHEMISTRY

All dried leaf samples were packed in double nylon bags and send to Canada- ACME Laboratories, which has ISO 9002 certificate for chemical analysis.

The samples were pulverized and prepared for the analysis by the ACME staff. According to the given report, 30 g of sample were dissolved for each determination in 180 ml 2-2-2 HC1 - HNO3 - H2O at 95 degree C for one hour and is diluted to 600 ml. Analysis made by ICP/ES and MS. for 50 elements.

Whole rock and REE analysis of the rocks, auriferous quartz veins and sulphide veins was made by ACME. For the analysis 0.2 g of the samples were fused with 1.5 g of LİBO2 and then dissolved in 100 ml 5 % HNO3. ICP/MS was used for the determination of Mo, Cu, Pb, Zn, Ni, As, Cd and Sb. For analysis, 0.5 gr sample is digested with 3 ml 2-2-2 HCl-HNO_3-H_2O at 95 degree and then diluted to 10 ml with water. Gold and Ag analysis were made by ICP/ES &MS in ACME-Canada, Meda Steel- Belgium and M.T.A. (Mineral Research and Exploration General Directorate of Turkey) in order to examine the reproducibility or accuracy of the results in the samples.

Chemical analyses of the leaf samples are given as "Table 1".

The geochemical analysis of diabasic dykes, gabbros are given in "Table 2", while the geochemical analysis of gold bearing quartz veins and sulphide lodes are summarized in "Table 3".

Some selected cross-examination graphics were prepared and shown as element versus element graphics in order to show the differences and/or similarities of the chemistry of the leaves in the mineralised and non-mineralised areas "Figure 1".

RESULTS AND DISCUSSION

The mean value of As was 3.57 ppm in the mining area, whereas the mean value of As was 0.656 ppm in the trees having no direct contact with any of the auriferous quartz veins or sulphide lodes. The average value of Zn in both areas were determined (33.6-22.4) respectively, whilst for S (0.160-0.121%), Au (1.86-1.63 ppb), Ag (9.8-7.42 ppb), Cd (0.128-0.066 ppm), Co (0.386-0.271 ppm), P (0.088-0.074 %), Na (0.018-0.0093 %), K (0.60-0.57%), Se (0.206-0.128 ppm), Y (0.087-0.060 ppm), Mn (118-106 ppm), Ba (3.26-3.15 ppm), Gd (0.026-0.013 ppm), Nd (0.069-0.038 ppm) and Sb (0.05-0.038 ppm).

The mean value of Mg in the leaves of the trees in the non-mineralised and mineralised areas were found 0.422 %, and 0.342 % respectively. The average value of Ni in the non-mining and mining areas were determined to be (15.21-4.31 ppm), Fe (0.057-0.027 %), Mo (0.031-0.027 ppm), Cr (1.36-0.85 ppm), B (33.0-25.9 ppm), Sr (21.63-21.02 ppm), Ba (3.47-3.26 ppm), Ca (1.01-0.93%), Al (0.033-0.021 %), Bi (0.036-0.032 ppm) and Ce (0.134-0.116 ppm).

Pahlsson (1989) and Steffens (1990) showed that Cu, Pb, Cd and Hg enrichments in trees are

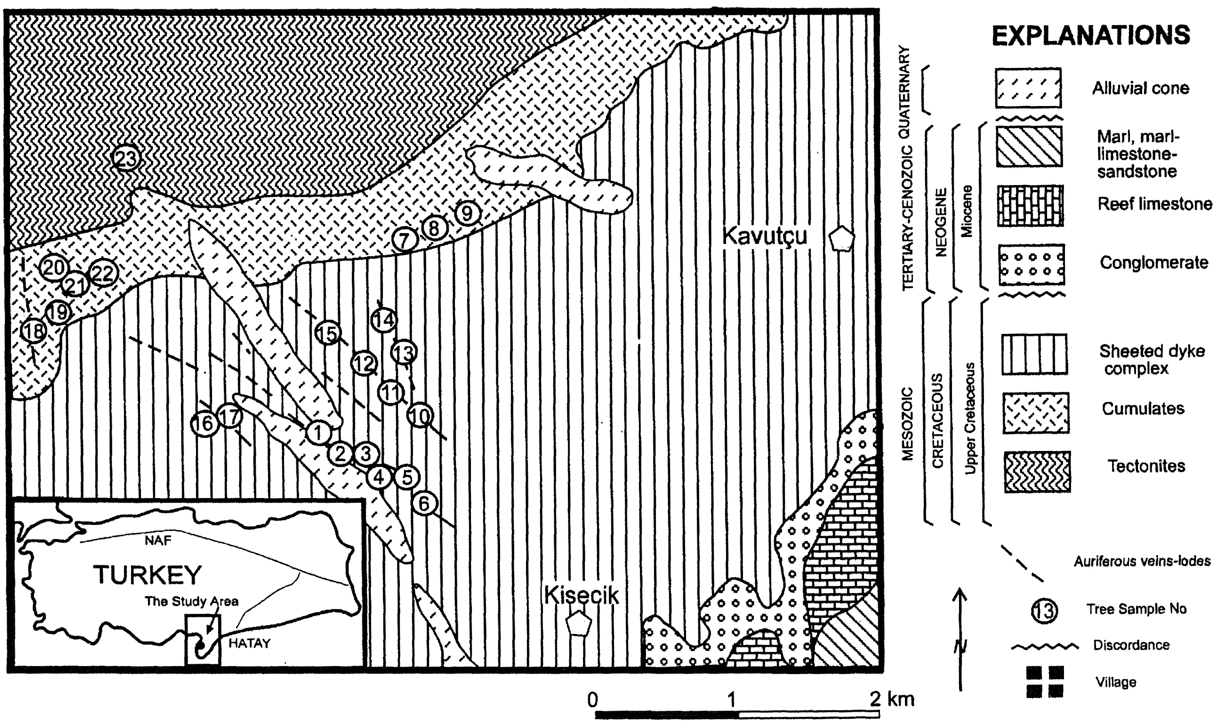

Figure 1: Simplified geological map and sample location in the study area

***Şekil** 1: Çalışma alanının basitleştirilmiş jeolojik haritası ve numune lokasyonları*

Table 1: The chemical analyses of 23 leaf samples. The number of the tree species is shown in brackets next to them and the last number is the representative sample of the non-mineralised area.

P. Orientalis (1, 4, 7), *A. andrachne* (10, 12, 13, 17, 18, 8), C *creticus* (6, 21), *S. alba* (16, 22), *A. glutinosa* (5, 23), *P latifolia* (3, 20), *Q. infectoria* (11, 14, 18), *Q. coccifera* (2, 9) and *P. lentiscus* (15).

Çizelge 1: 23 yaprak örneğinin kimyasal analizi. Ağaç örneklerinin numaraları parantez içinde gösterilmiş olup son numaralar cevhersiz bölgeden alınan numuneleri temsil etmektedir.

P Orientalis (1, 4, 7), A. andrachne (10, 12, 13, 17, 18, 8), C. creticus (6, 21), S. alba (16, 22), A. glutinosa (5, 23), P latifolia (3, 20), Q. infectoria (11, 14, 18), Q. coccifera (2, 9) and P lentiscus (15).

SAMPLE	Mo ppm	Cu Ppm	Pb ppm	Zn ppm	Ag ppb	Ni ppm	Co ppm	Mn Ppm	Fe %	As ppm	U ppm	Au ppb	Th ppm	Sr ppm	Cd ppm	Sb ppm	Bi ppm	V ppm
Y-99-8-1	.06	9.02	.28	13.4	6	2.8	.2	43	.03	6.2	<.1	2.9	<.1	4.3	.01	.09	.03	<2
Y-99-8-2	.03	11.92	.36	17.3	32	10.7	.2	96	.02	1.6	<.1	1.9	<.1	8.7	.03	.09	.02	<2
Y-99-8-3	.03	11.73	.28	41.5	5	15.5	.4	33	.03	2.0	<.1	1.3	<.1	12.4	.01	.03	<.02	<2
Y-99-8-4	.05	7.50	.39	10.5	4	7.7	.2	86	.03	2.0	<.1	2.7	<.1	7.1	.02	.06	<.02	<2
Y-99-8-5	.02	14.09	.39	44.6	9	10.6	.8	112	.05	2.7	<.1	1.5	<.1	10.3	.02	.03	<.02	<2
Y-99-8-6	.03	12.85	1.00	56.2	9	5.0	2.1	516	.07	16.4	<.1	3.3	<.1	9.6	1.81	.09	<.02	<2
Y-99-8-7	.02	10.85	.53	9.1	6	12.1	.3	33	.03	.8	<.1	1.0	<.1	11.8	.01	.03	<.02	<2
Y-99-8-8	.02	13.47	.40	29.2	8	2.0	.3	43	.03	.6	<.1	1.3	<.1	67.6	.13	.06	.13	<2
Y-99-8-9	.03	5.20	.18	14.2	5	1.4	.2	111	.03	.6	<.1	.9	<.1	26.3	.02	< .02	<.02	<2
Y-99-8-10	.02	3.80	.30	28.9	5	.9	.1	24	.02	1.6	<.1	1.6	<.1	27.9	.51	.03	<.02	<2
Y-99-8-11	.02	17.22	.60	33.0	8	1.3	.2	276	.02	1.5	<.1	.9	<.1	17.2	.22	.04	<.02	<2
Y-99-8-12	.01	9.59	.37	30.4	6	.9	.2	26	.02	2.2	<.1	1.5	<.1	51.3	.26	.06	.18	<2
Y-99-8-13	.02	9.89	.29	21.9	10	.8	.1	22	.02	2.5	<.1	1.7	<.1	38.9	.08	.05	.03	<2
Y-99-8-14	.02	16.68	.65	29.4	8	1.8	.4	301	.03	1.8	<.1	1.8	<.1	24.2	.15	.04	<.02	<2
Y-99-8-15	.04	14.17	.56	14.8	10	1.0	.2	53	.03	1.9	<.1	3.0	<.1	37.1	.03	.05	<.02	<2
Y-99-8-16	.03	10.73	.34	138.0	7	1.7	.4	160	.02	9.2	<.1	.7	<.1	21.5	.31	.02	<.02	<2
Y-99-8-17	.02	13.01	.55	36.7	10	3.1	.2	23	.02	1.1	<.1	1.7	<.1	26.0	.12	.05	<.02	<2
Y-99-8-18	.01	9.36	.46	31.4	18	.9	.1	27	.03	.9	<.1	1.1	<.1	18.9	.16	.03	<.02	<2
Y-99-8-19	.01	33.16	.85	22.7	13	7.2	.4	44	.03	.6	<.1	2.5	<.1	7.1	.01	.04	<.02	<2
Y-99-8-20	.04	7.70	.63	9.8	4	11.0	.7	17	.04	.6	<.1	1.4	<.1	12.4	.02	.04	<.02	<2
Y-99-8-21	.04	7.91	.84	24.4	8	51.5	3.5	44	.18	.8	<.1	2.1	<.1	6.7	.11	.04	<.02	<2
Y-99-8-22	.08	13.86	.77	47.1	10	20.7	6.5	450	.06	.6	<.1	2.2	<.1	15.6	.15	.03	<.02	<2
Y-99-8-23	.02	38.86	1.88	46.9	12	7.4	1.1	79	.04	1.9	<.1	5.9	<.1	11.1	.02	.05	<.02	<2

SAMPLE	Ca %	P %	La ppm	Cr ppm	Mg %	Ba ppm	Ti %	B ppm	Al %	Na %	K %	W ppm	Tl Ppm	Hg ppb	Se ppm	Te ppm	Ga ppm	S %
Y-99-8-1	.75	.109	<.5	<.5	.26	.8	.001	14	.02	.009	.56	.3	<.02	<5	.4	<.02	<.1	.18
Y-99-8-2	.67	.095	<.5	3.4	.30	11.9	<.001	35	.01	.004	.70	<.2	<.02	18	.1	<.02	<.1	.15
Y-99-8-3	.78	.084	<.5	1.9	.24	2.7	.001	18	.02	.008	1.09	<.2	<.02	<5	<.1	<.02	.1	.11
Y-99-8-4	1.71	.096	<.5	<.5	.39	.7	<.001	23	.01	.010	.45	<.2	<.02	10	.2	<.02	<.1	.38
Y-99-8-5	1.48	.107	<.5	.5	.51	1.1	.001	32	.04	.014	.53	<.2	<.02	6	.3	<.02	.1	.14
Y-99-8-6	.83	.129	<.5	1.5	.34	1.8	.001	17	.05	.124	.56	<.2	<.02	9	.4	<.02	.2	.17
Y-99-8-7	.96	.077	<.5	.5	.34	1.2	<.001	14	.02	.008	.60	<.2	<.02	12	.1	<.02	.1	.12
Y-99-8-8	1.81	.061	<.5	<.5	.37	7.5	.001	38	.04	.007	.43	<.2	<.02	10	.2	.05	.1	.08
Y-99-8-9	1.69	.069	<.5	2.8	.12	2.4	.001	32	.05	.010	.48	<.2	<.02	<5	<.1	<.02	.1	.08
Y-99-8-10	.84	.083	<.5	<.5	.43	4.8	<.001	12	.01	.006	.47	<.2	<.02	<5	.1	<.02	<.1	.07
Y-99-8-11	.92	.060	<.5	<.5	.25	1.0	<.001	45	.01	.011	.61	<.2	<.02	22	.1	<.02	<.1	.12
Y-99-8-12	.72	.070	<.5	<.5	.49	3.9	.001	11	.02	.007	.38	<.2	<.02	8	<.1	.08	<.1	.10
Y-99-8-13	.75	.068	<.5	<.5	.30	6.9	<.001	23	.01	.005	.56	<.2	<.02	6	.1	.03	<.1	.11
Y-99-8-14	.77	.060	<.5	<.5	.29	1.7	.001	39	.01	.016	.84	<.2	<.02	15	.1	<.02	<.1	.12
Y-99-8-15	1.32	.072	<.5	<.5	.24	2.0	.001	80	.01	.011	1.01	<.2	<.02	19	.2	<.02	<.1	.13
Y-99-8-16	1.82	.099	<.5	<.5	.51	.8	.001	12	.02	.010	.98	<.2	<.02	<5	.6	.02	.1	.45
Y-99-8-17	.88	.114	<.5	<.5	.38	6.2	.001	16	.02	.011	.37	<.2	<.02	17	<.1	<.02	.1	.11
Y-99-8-18	.76	.073	<.5	<.5	.20	2.6	<.001	11	.01	.005	.68	<.2	<.02	<5	.2	<.02	<.1	.07
Y-99-8-19	.54	.057	<.5	<.5	.40	1.7	.001	25	.01	.005	.42	<.2	<.02	<5	.1	<.02	<.1	.08
Y-99-8-20	.95	.094	<.5	3.3	.32	2.6	.001	63	.02	.006	.86	<.2	<.02	27	.1	<.02	.1	.13
Y-99-8-21	.67	.077	<.5	13.0	.68	5.9	.003	32	.06	.026	.46	<.2	<.02	17	<.1	<.02	.2	.14
Y-99-8-22	.81	.083	<.5	.6	.73	2.0	.001	27	.03	.004	.79	<.2	<.02	16	.2	<.02	.1	.22
Y-99-8-23	.78	.145	<.5	<.5	.45	.9	.001	20	.03	.007	.49	<.2	<.02	19	.2	<.02	.1	.23

SAMPLE	Y Ppm	Ce ppm	Pr ppm	Nd ppm	Sm ppm	Eu ppm	Gd ppm	Tb ppm	Dy ppm	Ho ppm	Er ppm	Tm ppm	Yb ppm	Lu Ppm
Y-99-8-1	.05	.13	.02	.08	.02	<.02	.02	<.01	.02	<.02	<.02	<.01	.01	<.02
Y-99-8-2	.02	.06	<.02	.03	<.02	<.02	<.02	<.01	<.02	<.02	<.02	<.01	.01	<.02
Y-99-8-3	.05	.12	.02	.07	<.02	<.02	.02	<.01	<.02	<.02	<.02	<.01	.01	<.02
Y-99-8-4	.12	.12	.02	.08	.02	<.02	.02	<.01	.02	<.02	<.02	<.01	.01	<.02
Y-99-8-5	.10	.15	.02	.08	.02	<.02	.03	<.01	.02	<.02	<.02	<.01	.01	<.02
Y-99-8-6	.28	.30	.04	.20	.05	<.02	.08	.01	.05	<.02	<.02	<.01	.02	<.02
Y-99-8-7	.03	.07	<.02	.04	<.02	<.02	<.02	<.01	<.02	<.02	<.02	<.01	<.01	<.02
Y-99-8-8	.03	.08	<.02	.05	<.02	<.02	<.02	<.01	<.02	<.02	<.02	<.01	.01	<.02
Y-99-8-9	.03	.07	<.02	.04	<.02	<.02	<.02	<.01	<.02	<.02	<.02	<.01	<.01	<.02
Y-99-8-10	.04	.09	<.02	.06	<.02	<.02	<.02	<.01	<.02	<.02	<.02	<.01	<.01	<.02
Y-99-8-11	.07	.11	<.02	.06	<.02	<.02	.02	<.01	<.02	<.02	<.02	<.01	<.01	<.02
Y-99-8-12	.03	.06	<.02	.04	<.02	<.02	<.02	<.01	<.02	<.02	<.02	<.01	<.01	<.02
Y-99-8-13	.03	.05	<.02	.03	<.02	<.02	<.02	<.01	<.02	<.02	<.02	<.01	<.01	<.02
Y-99-8-14	.09	.14	.02	.08	.02	<.02	.02	<.01	.02	<.02	<.02	<.01	.01	<.02
Y-99-8-15	.29	.15	.02	.12	.02	<.02	.04	.01	.03	<.02	<.02	<.01	.01	<.02
Y-99-8-16	.05	.09	<.02	.05	<.02	<.02	.02	<.01	<.02	<.02	<.02	<.01	.01	<.02
Y-99-8-17	.07	.11	.02	.07	.02	<.02	.02	<.01	<.02	<.02	<.02	<.01	.01	<.02
Y-99-8-18	.01	.06	<.02	.04	<.02	<.02	<.02	<.01	<.02	<.02	<.02	<.01	<.01	<.02
Y-99-8-19	.03	.10	<.02	.06	<.02	<.02	.02	<.01	<.02	<.02	<.02	<.01	.01	<.02
Y-99-8-20	.04	.13	.02	.08	<.02	<.02	.02	<.01	<.02	<.02	<.02	<.01	.01	<.02
Y-99-8-21	.20	.39	.06	.23	.04	<.02	.06	.01	.04	<.02	<.02	<.01	.02	<.02
Y-99-8-22	.06	.10	<.02	.07	.02	<.02	.02	<.01	<.02	<.02	<.02	<.01	.01	<.02
Y-99-8-23	.05	.09	<.02	.08	<.02	<.02	.02	<.01	<.02	<.02	<.02	<.01	.01	<.02

Table 2: The geochemical analyses of the diabasic dykes and gabbros.

Çizelge 2: Diyabaz dayklan ile gabroların kimyasal analizleri.

	Diabase Dykes (Have a direct contact with auriferous lodes-veins) $\overline{X}$ (n=6) range	Diabase Dykes (Have no direct contact with auriferous lodes-veins) $\overline{X}$ (n=6) range	Gabbros (Have contact with auriferous lodes-veins) $\overline{X}$ (n=6) range	Gabbros (Have no contact with any auriferous lodes-veins) $\overline{X}$ (n=5) range
SiO_2	50.02 (43.6-54.68)	52.49 (48.70-55.0)	47.05 (41.41-49.47)	48.08 (46.73-49.03)
MgO	10.0 (7.077-17.21)	8.84 (8.02-13.60)	9.85 (8.067-10.629)	9.62 (8.66-11.03)
CaO	2.40 (0.09-6.70)	7.45 (5.50-8.50)	11.205 (8.04-11.203	11.06 (6.03-12.07)
Fe_2O_3	9.98 (6.69-11.15)	8.81 (8.20-10.0)	5.75 (5.2-6.43)	7.34 (4.43-8.36)
K_2O	0.257 (0.18-0.399)	0.358 (n.d.-0.84)	0.249 (0.206-0.302)	0.25 (0.21-0.315)
Na_2O	1.45 (1.39-1.46)	2.83 (1.78-3.95)	1.165 (1.15-1.21)	1.50 (1.03-2.09)
TiO_2	0.61 (0.36-0.862)	0.35 (0.24-0.99)	0.313 (0.293-0.333)	0.30 (0.28-0.323)
Al_2O_5	14.56 (13.50-15.58)	15.916 (12.0-15.50)	13.91 (14.50-17.95)	17.16 (16.91-18.83)
MnO	0.154 (0.050-0.235)	0.11 (0.05-0.18)	0.082 (0.061-0.1)	0.11 (0.09-0.14)
As	0.336 (0.239-0.105)	0.092 (0.07-0.105)	0.250 (0.184-0.305)	0.009 (n.d.-0.01)
Zn	0.123 (0.080-0.212)	0.089 (0.070-0.11)	0.066 (0.031-0.082)	n.d.
Cu	0.11 (0.070-0.222)	0.070 (0.04-0.098)	0.006 (0.001-0.010)	n.d.
S	0.275 (n.d.-1.207)	0.236 (0.117-0.332)	0.003 (0.001-0.008)	0.012 (0.006-0.018)
P_2O_5	0.132 (0.025-0.058)	0.04 (0.02-0.058)	0.024 (0.013-0.032)	0.05 (0.03-0.065)
Ni	0.205 (0.078-0.80)	0.10 (0.07-0.12)	0.85 (0.042-0.12)	0.15 (0.092-0.167)
LoI	8.89 (6.77-11.02)	3.91 (2.82-4.37)	8.63 (4.13-12.31)	3.42 (1.66-5.018)
Total:	**99.47**	**101.691**	**100.436**	**99.591**
Note: Total Fe as Fe_2O_3				

closely related with the flora metabolism system and might cause poisining. Nevertheless, it was noticed that copper was especially preferred by small sized trees such as *C. creticus, P. latifolia* and *Q. infectoria,* whereas lead especially was preferred by *Q. infectoria* and *C. creticus.* Furthermore, Cu and Pb were determined to be preferred by relatively higher trees such as *P. oriantalis, S. alba* and *A. andrachne.* Their contents are particularly more in the non-mineralised area.

Relatively higher values of Pb, Ni, Co, Mn, Fe, Au, Bi, P, Cr, Al, Na, Ga, Y, Ce, Pr, Nd, Sm, Gd and Dy were determined in mineralised areas especially in the *C. creticus,* which is the smallest plant among the studied plants. The highest values of Mo, Zn, Co, Mn, Cd, Ca, Mg, Se and S were determined in *S. alba.*

According to these results it can be easily said that accumulation of gold and other elements in the leaves has no positive correlation with the size of the trees and the depth of the roots.

According to Pahlsson's (1989) study in Sweden, Cu and Pb appear to be accumulated in the roots and the contents in the leaves remain at the normal level until the roots are saturated.

Most probably because of this reason, the deep rooted tree's leaves in the mineralised area such as *P. oriantalis* (Cu, Ag, K, Cd, Ca, Sr), *A. andrachne* (Cu, Mo, Mn, Ca, Na, Sr, Se, B), *A. glutinosa* (Au, Cu, Ag, S, Mo, Cd) and *S. alba* (Au, Cu, Ag, Mo, Mn, Y, B) were found to be poorer in some elements, which are shown in brackets.

Some selected element's normal levels of the leaves and their comparison with the studied leaves in the mineralised and non-mineralised areas are shown in "Table 4".

According to these values, it can be easily stated that the leaves were enriched in Zn, As, Cu, Mn, Ca, Mg, S, Al, Cr, Co, Ni and Se, whereas the level of the Fe, K, P, Na values were found to be decreased if they are compared with the mean values of the relevant elements given by Finck (1969).

Significant positive correlation were detected between As-Mn, Fe-Co, Mn-Co, Mn-Pb, As-Pb, Zn-Co and Mn-Fe. Correlation coefficients of some selected elements are shown in "Table 5". Furthermore, reasonably high positive correlation especially between the concentration of gold and arsenic was detected. Plants containing high "As" concentrations were found generally to have relatively higher levels of gold. In other words, "As" can probably be used in some circumstances in biogeochemical prospecting to locate the area of gold anomaly in the study area.

The concentration and interrelation of As, Zn, Cu, Fe, Pb, Mn in relation with Au in mineralised and non-mineralised areas are given in "Figure 2".

Some peculiarities were detected during the

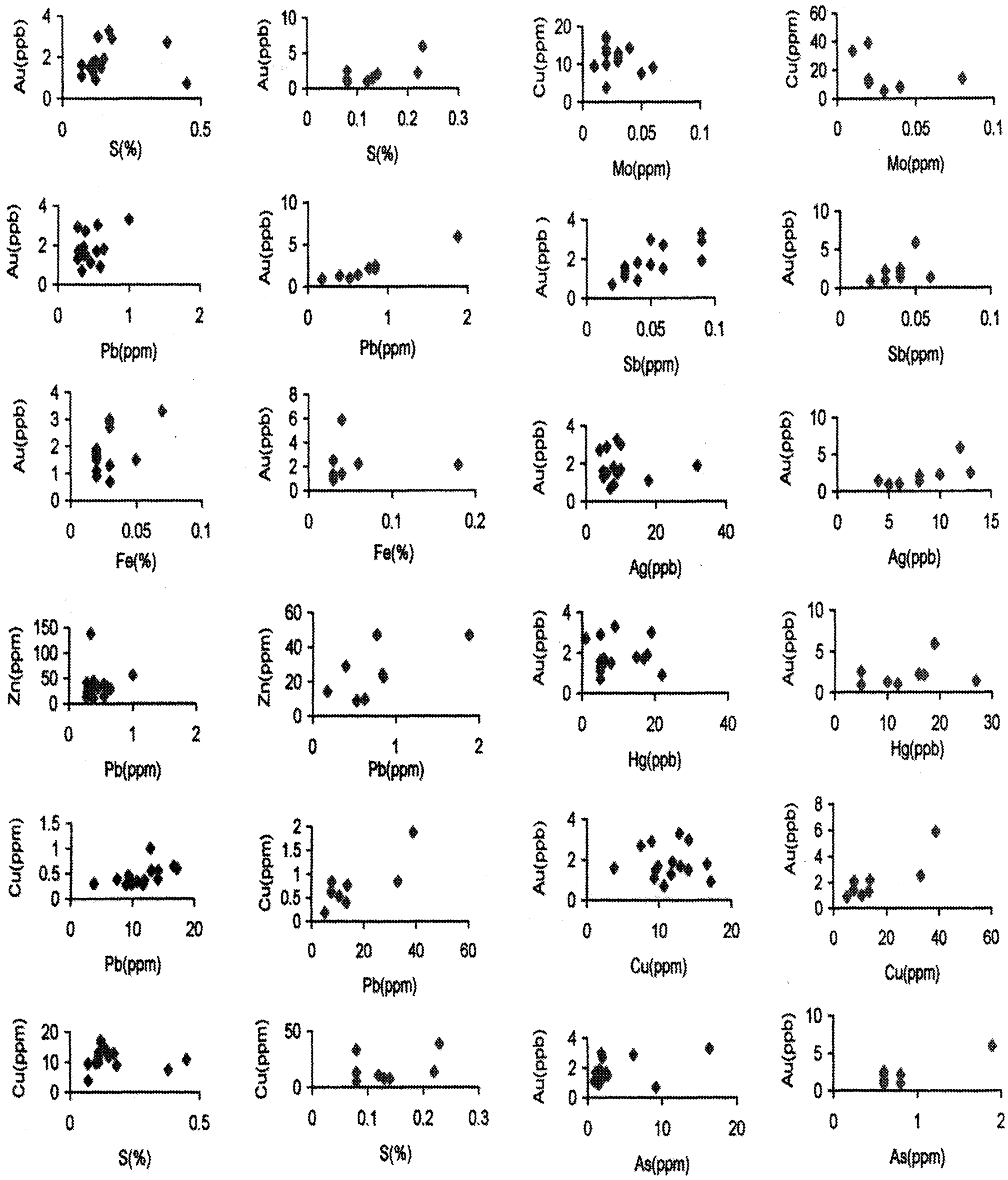

Figure 2: Graphical illustration of the concentration and interrelation of As, Zn, Cu, Fe, Pb, Mn and their relation with Au. The first graphic always represents mineralized zone, whilst the second always represents non-mineralized area as used same couple-elements for graphics.

Şekil 2: *As, Zn, Cu, Fe, Pb, Mn konsantrasyonlarının birbirleri ile ve altın konsantrasyonu ile ilişkilerini gösteren grafikler. Aynı elementler ile oluşturulan grafiklerin ilki mineralleşmiş zonu, ikincisi mineralleşmemiş zonu temsil etmektedir.*

Table 3: The geochemical analyses of the auriferous quartz veins and sulphide lodes.

Çizelge 3:Altın içeren kuvars damarları ile sülfit damarlarının kimyasal analizleri.

	Gold bearing quartz veins diabase dykes X (n=28) Range	Sulphide veins in Diabase dykes X (n=23) Range	Gold bearing quartz veins in gabbros X (n=4) Range
SiO_2	79.976 (61.94-88.03)	41.470 (28.11-60.0)	85.58 (77.52-89.45)
MgO	0.205 (n.d.-0.55)	0.71 (0.03-1.95)	0.01 (n.d.-0.05)
CaO	0.105 (n.d.-0.40)	0.21 (n.d.-0.90)	0.06 (n.d.-0.09)
Fe_2O_3	6.45 (2.65-13.3)	23.20 (14.24-32.2)	4.43 (2.22-5.97)
K_2O	0.273 (0.10-0.70)	0.325 (0.10-0.90)	0.26 (0.152-0.399)
Na_2O	0.10 (n.d. 0.15)	0.213 (n.d.-0.55)	0.09 (n.d.-0.190)
TiO_2	0.084 (n.d.-0.60)	0.183 (0.06-0.40)	0.026 (0.006-0.066)
Al_2O_3	1.714 (0.60-3.62)	4.64 (0.2-17.2)	1.27 (0.56-2.80)
As	1.484 (0.147-4.33)	13.82 (6.53-36.05)	0.73 (0.316-1.71)
Zn	0.314 (0.09-1.30)	3.29 (0.70-7.30)	0.12 (0.09-0.19)
Cu	0.239 (0.09-0.765)	2.03 (0.26-3.70)	0.16 (0.077-0.251)
S	0.319 (n.d.-0.773)	3.3 (2.01-4.70)	0.418 (0.016-1.147)
P_2O_5	0.037 (0.01-0.10)	0.1 (0.02-0.2)	0.055 (0.012-0.180)
Mn	0.067 (0.005-0.208)	0.07 (0.04-0.1)	0.015 (0.007-0.020)
Ni	0.06 (n.d.-0.093)	0.06 (0.04-0.09)	0.089 (0.085-0.094)
LoI	8.81 (1.23-13.02)	4.46 (1.27-6.36)	5.21 (3.47-6.92)
Au (ppm)	3.78 (0.87-15.8)	10.14 4(1.27-30.3)	2.99
Ag (ppm)	10.388 (0.5-23.8)	22.513	3.88
Total	**100.23**	**99.46**	**99.631**
Au/Ag	**0.364**	**0.45**	**0.77**
Note: Total Fe as Fe_2O_3			

comparison of the chemistry of the leaves in gold bearing veins and rock analyses. Some elements, such as Mn, Co, Pb, Ni and Sr were found in small concentrations in the studied veins and rocks, but somehow the analysis of the leaves showed that these elements appeared to be comparatively and unexpectably high in concentration in the studied leaves. For instance the Mn levels in gold bearing sulphide veins and quartz veins are very low and range between 100-3000 ppm, whereas the Mn values in the leaves vary between 23-516 ppm.

In the same sense, the Co values in the veins and rocks vary between (3.7-52.2 ppm), Pb (7-2162 ppm), Ni (9-290 ppm), Sr (1.4-150 ppm), whereas the values changes in the leaves (0.2-6.5 ppm), (0.28-1.88 ppm), (0.9- 51.5 ppm) and (4.3-67.6) respectively.

Perelman (1967) and Rose and others (1979) pointed out that Mn, Ni, Pb and Co are slightly mobile (K=Mobility coefficient^, 1-1) elements in water under oxidising condition (pH=5-8). But these elements become moderately mobile and naturally the uptake by some plants will be much stronger, if the oxidising condition becomes more acidic (pH < 4). Because of this reason, it can be stated, that the condition should have been strongly acidic during the uptake process of the relevant plants in the study area.

On the contrary, some elements such as Fe and Al, which are normally in high concentration in the rocks and veins found to be very low in concentrations in the studied leaves.

The reason for these peculiarities have not been well understood yet, but most probably it is related with the low solubility of those elements in water and/or production of the phytochelatins, thus plants simply uptake some elements easier than the others. According to Rose and others (1979), these elements considered to be immobile (K < 0.1).

The function of the elements are not always clearly defined by the authors and there are many controversies between the relevant statements, but generally it is said that, Cd, Pb, Zn, Sb, Ag, Ni, Hg, Cu, Sn, Au, Bi, Fe and W all induce phytochelatins. According to Grill and others(Grill and others, 1987), among the common metals, Cd is the strongest inducer, whereas Zn appears to be weak requiring very high level for induction. On the other hand, Pahlsson (1989) stated that Zn and Cu are essential elements for higher plants and are involved in several metabolic processes, whereas Pb and Cd are not known to have any function in plants. Heavy metals such as Zn and Cu are required by biological systems as structural and catalytic components of proteins and enzymes, and as co-factors essential to normal growth and development. In excess, these micronutrients and related heavy metals such as Cd, Hg, Ni and Pb became extremely toxic to cells (Steffens, 1990). These heavy metal-binding polypeptides are known as phytochelatins. The role of phytochelatins in plant metal tolerance has been the subject of several recent review (Rauser (1990), Robinson and Jackson (1986), Robinson (1990), Tomsett and Thurman(1988)).

Rennenberg (1987) pointed out that pytochelatins play a central role in the detoxification of excess metals.

Many more studies can be given as references but so far no study was found to solve all problems related with the metallic element uptake regime of the studied plants.

According to Pahlsson (1989), present knowledge is not enough to propose a limit for normal and toxic concentration of Zn, Cu, Cd, Pb and other elements in the plants.

- Most tree species have mycorrhiza which at

Table 4: Some selected element's normal level in the leaves and their comparison with the studied leaves in mineralised and non-mineralised areas. The capital letters in brackets represent the species, which have the highest and the lowest concentrations. For instance Po stands for *P. oriantalis.* Normal level of the elements were taken from Finck(1969).

Çizelge 4: Bazı seçilmiş elementlerin yapraklardaki normal değerleri ve bu değerlerin cevherli ve cevhersiz bölgelerdeki örnek değerleri ile karşılaştırılması. Parantez içindeki büyük harfler en yüksek ve en düşük konsantrasyona sahip türü temsil etmektedir.örneğin Po, P Oriantalis anlamınadır.Elementlere ait normal değerler Finck (1969)' dan alınmıştır.

	In Leaves (Finck, 1969) (mean values in brackets)	Mineralised Area			Non-mineralised Area		
		Min	Max	$\bar{x}$	Min	Max	$\bar{x}$
Zn	10-100 (30) ppm	10.5 (Po)	138 (Sa)	33.56	9.1 (Po)	47.1 (Sa)	25.54
As	0.1-0.5 ppm	0.9 (Aa)	16.4 (Cc)	3.57	0.6 (Aa)	1.9 (Ag)	0.656
Cu	2-20 (7) ppm	3.8 (Aa)	17.22 (Qi)	11.437	5.2 (Qc)	38.86 (Ag)	13.164
Fe	50-1000 (50) ppm	20 (Aa)	50 (Ag)	27.3	30 (Aa)	180 (Cc)	55
Mn	20-200 (40) ppm	22 (Aa)	516 (Cc)	118	17 (Pl)	450 (Sa)	102.6
K	0.5-5 (2.5) %	0.37 (Po)	1.09 (Pl)	0.6	0.42 (Qi)	0.86 (Pl)	0.57
Ca	0.05-5 (1) %	0.67 (Qc)	1.82 (Sa)	0.93	0.54 (Qi)	1.81 (Sa)	0.95
Mg	0.1-1 (0.2) %	0.24 (Pl)	0.51(Sa, Ag)	0.342	0.12 (Qc)	0.73 (Sa)	0.422
S	0.05-0.5 (0.2) %	0.07 (Po)	0.45 (Sa)	0.16	0.08 (Po)	0.23 (Ag)	0.121
P	0.1-0.5 (0.3) %	0.06 (Qi)	0.129 (Cc)	0.08	0.057 (Qi)	0.094 (Ag)	0.074
Na	500-30000 ppm	40 (Qc)	1240 (Cc)	177	40 (Sa)	260 (Cc)	90
Al	20-50 ppm	100	500 (Cc)	206	100 (Qi)	600 (Cc)	325
Cr	0.1-1 ppm	<0.5	3.4 (Qc)	0.853	<0.5	13 (Cc)	1.357
Co	0.03-0.5 ppm	0.1 (Aa)	2.1 (Cc)	0.386	0.2 (Qc)	6.5 (Sa)	0.375
Ni	0.1-2 ppm	0.9 (Aa)	15.5 (Pl)	4.31	1.4 (Qc)	51.5 (Cc)	14.16
Se	0.1 ppm	<0.1	0.6 (Sa)	0.206	<0.1	0.2 (Sa)	0.137
Sr	10-100 ppm	4.3 (Po)	51.3 (Pl)	21.02	6.7 (Cc)	67.6 (Aa)	21.63

least at lower concentration can protect the root from taking up heavy metals.

- Some elements appeared to be accumulated in the roots and the contents in the leaves at a normal level until the roots are saturated.

- Absence of mycorrhiza may increase the metal uptake and thus the risks of the root» injury.

- External condition such as draught and parasite attacks may effect the mineral uptake regime of the trees.

Furthermore the water content of the soil is found to be very important for the "uptake" of heavy metal elements. As known , plants will uptake copper as Cu^{+2}, Mn as $Mn^{+\wedge}$ and Fe, as Fe^{+2}. Wherever water occupies all of the porosities in the soil (stream environment and heavy rain areas), the amount of oxygen in the soil decreases and under this reduced condition plants may uptake more heavy metals. Probably because of this reason, the leaves of the *S. alba* have the highest amount of Mo, Zn, Co, Mn, Cd, Mg and Se in non-mineralised areas "Kaçar and Katkat (1999); and personal communication with Prof. Dr. Rıfat Yalçın".

The analyses of the REE in the leaves were not found to be useful for comparison, just because one has no chance to normalize these determined values with anything. Nevertheless, the highest values of Y, Ce, Pr, Nd, Sm and Dy were determined in the *C. creticus,* which is the smallest and shallow rooted plant among the studied plants.

CONCLUSIONS

Biochemical and Geochemical data have shown that plant metallic element concentration correlate strongly with the soil element concentrations with some exceptions. As a matter of fact, besides total metallic element content, many factors concerning plant and soil, such as injury of roots, draft, pollution may influence the total metallic element content of plant's leaf.

As it was pointed out earlier that, some of the

Table 5: The correlation coefficient of some selected elements from the studied leaf samples.

Çizelge 5: Çalışılan yapraklardaki bazı seçilmiş elementlerin korelasyon katsayıları.

	Au (ppb)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Mn (ppm)	Fe (%)	As (ppm)	Sr (ppm)	Sb (ppm)
Au (ppb)	1										
Cu (ppm)	-0,0673	1									
Pb (ppm)	0,39544	0,54282	1								
Zn (ppm)	-0,4491	0,0759	0,06168	1							
Ni (ppm)	0,03421	0,08604	-0,1795	-0,0526	1						
Co (ppm)	0,41802	0,2571	0,73379	0,2971	0,2223	1					
Mn (ppm)	0,24915	0,51428	0,84532	0,28371	-0,0307	0,79914	1				
Fe (%)	0,49454	0,15974	0,55197	0,26098	0,3217	0,92842	0,62068	1			
As (ppm)	0,39725	0,02617	0,53336	0,052157	-0,027	0,8411	0,69285	0,79093	1		
Sr (ppm)	-0,2073	-0,0661	-0,0942	-0,02861	-0,5844	-0,3284	-0,30885	-0,422	-0,2852	1	
Sb (ppm)	0,73303	-0,0283	0,27264	-0,41361	0,0938	0,3254	0,25016	0,28433	0,38114	-0,26489	1

elements content in the soil, such as Mn, Ni, Co, Pb, Sr, Fe and Al are not reflected in relative proportion in plant's leaves.

In general, the average values of As, Zn, S, Au, Ag, Cd, Co, P, Na, K, Sb, Se, Y, Mn, Gd and Nd were determined to be higher in the leaves of the studied trees, which have direct contacts with the gold bearing quartz veins and sulphide veins.

The size of the trees in the study do not appear to be important for the accumulation of the heavy metallic elements in the leaves. *C. creticus,* which is the smallest plant among the studied trees, is noticed to be most sensitive to the soil chemistry. The *C. creticus,* contains Pb, Ni, Co, Cd, Mn, Fe, Au, Bi, P, Cr, Al, Na, Ga, Y, Ce, Pr, Nd, Sm and Dy in higher level than the rest.

Gold accumulation in the leaves were determined to have a reasonable high correlation coefficient with As. This element may be used to locate the gold enriched areas.

Finally, it can be stated that the leaves can be used as indicator for the gold bearing quartz veins and sulphide lodes.

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GENİŞLETİLMİŞ ÖZET

Hatay ili merkezine 11 km uzaklıkta bulunan Kisecik köyü ve çevresinde, altın ve gümüş içeren kuvars ve sülfit damarlarının bulunduğu bölgede, Çınar, Sandal, Kızılağaç,Söğüt,Pürem, Sakızlık, Çitlembik, Karapelit ve Pelit gibi 9 bitki türünden 23 yaprak örneği alınarak 50 element üzerinde yapılan çalışmada, bitkilerin, bulundukları bölgeden etkilenme dereceleri araştırılmıştır (Şekil 1).

Seçilen bitkiler,sadece çalışılan bölgede yaygın olmayıp,Türkiye'nin batı ve güney taraflarında oldukça yaygın durumdadır. Çalışma esnasında toplanan bitki yaprak numuneleri, daha önceki çalışmalarda (Aydal,1989) altın içerdiği bilinen kuvars ve sülfit damarları ile, bunların dokanağmdaki alterasyon bölgeleriyle doğrudan temasta bulunan ağaçlardan alınmıştır. Ayrıca aynı ağaç tiplerinin, altın ve gümüş içermediği bilinen, gabro, diyabaz ve harzburjit gibi kay açların üzerlerinde yetişenlerden de yaprak örneği alınmıştır.

Altın ve gümüş içeren kuvars ve sülfit damarları ile doğrudan temasta görülen bitkilerdeki As değerinin ortalama olarak 3.57 ppm, aynı bitkilerin madenle doğrudan temasta bulunmadığı bir bölgeden alman numunelerdeki As ortalama değeri ise 0.656 ppm olarak bulunmuştur. Benzer şekilde, Zn değerleri ortalama olarak (33.56-22.49 ppm), S (%0.16-0.12), Au (1.86-1.63 ppb), Ag (9.8-7.42 ppb), Cd (0.128-0.066 ppm), Co (0.39-0.27 ppm), P (%0.088-0.074), Na (%0.018-0.009), K (%0.60-0.57), Se (0.206-0.13 ppm), Y (0.087-0.06 ppm), Mn (118-105.97 ppm), Gd (0.026-0.013 ppm), Nd (0.069-0.038 ppm) ve Sb (0.05-0.038ppm) olarak bulunmuştur (Çizelge 1).

Bunun yanısıra, bir kuvars veya sülfit damarlarıyla doğrudan bir bağlantı görülmeyen bölgelerde, aynı bitkiler kullanılarak yapılan çalışmada, bu kez bitkilerin, özellikle, bulundukları bölgedeki ultrabazik kayaçlardan etkilendikleri ve Mg, Ni, Fe, Mo, Cr, B, Sr, Ca, Ba, Al, Bi, Pr ve Ce değerlerinin daha yüksek olduğu belirlenmiştir. Buna göre, bu bölgedeki bitkilerden elde edilen Mg ortalama değeri % 0.422 iken, bu değerin kuvars ve sülfit damarları üzerindeki bitkilerde % 0.342 olduğu, benzer şekilde Ni değerinin ortalama olarak her iki bölgede (15.12-4.31 ppm), Fe (%0.057-0.027), Mo (0.0313-0.027 ppm), Cr (1.36-0.85 ppm), B (33.0-25.86 ppm) Sr (21.63-21.02 ppm), Ba (3.47-3.26 ppm), Ca (% 1.0085-0.93), Al (% 0.033-0.021), Bi (0.036-0.032 ppm), Hg (14.5-10ppb) ve Ce değerinin (0.134-0.116 ppm) gibi farklılıklar gösterdiği belirlenmiştir.

Bakır, kurşun,kadmiyum ve cıva'nm ortamda aşırı artışının bitki metabolizmasını yakından ilgilendirdiği ve zehirlenmeye sebep olduğu bilinmektedir. Ancak çalışılan bölgede özellikle bakır ve kurşunun bazı bitkiler tarafından özellikle tercih edildikleri görülmüştür. Maden bölgesindeki susuz topraklarda Pürem, Sakızlık ve Pelit gibi bitkilerde, kurşunun ise Pelit ve Pürem gibi küçük boylu bitkilerde arttığı, madence steril olduğu düşünülen sulu bölgelerde ise, bakır ve kurşunun birlikte artarak Çınar, Söğüt, Sandal gibi iri boyutlu bitkilerde daha fazla yoğunlaştığı belirlenmiştir.

Damarlar üzerinde bulunan bitkiler ve madence steril olduğu düşünülen bölgelerde bulunan bitkilerdeki Te, Ga, Nd, Sm ve Dy değerleri farklılık göstermemektedir. Ayrıca, bitkilerdeki U, Th, V, La, Ti, W, Tl, Ho, Tb, Er, Tm, Yb ve Lu değerleri ise dedeksiyon limitlerinin altında olması sebebiyle belirlenememiştir.

Ancak ortaya çıkan bir başka önemli sonuçta, bitkiler içindeki element artış ve eksilişinin bitki cinsinin yanısıra ,elementlerin su içindeki hareketlilik katsayısına bağlı olduğunun da ortaya konmuş olmasıdır. Buna göre kayaçlarda ve cevherlerde fazla miktarda olmalarına rağmen demir ve aliminyum gibi elementler, hereketlilik katsayılarının düşüklüğü sebebiyle yapraklarda çok düşük değerlerde bulunmaktadır. Buna karşılık, Mn,Co, Pb, Ni, ve Sr gibi ,çalışılan bölgede oldukça az bulunan elementler , sudaki hareketlilik katsayılarının fazla olması sebebiyle ,yapraklarda oldukça fazla değerde çıkabilmektedirler.

Çalışılan bölgede bulunulan ortamdan en çok etkilenen bitkilerin Pürem ve Söğüt olduğu görülmektedir.Ortamdaki Pb, Ni, Co, Mn, Fe, Au, Cd (Maden bölgesi), Bi, P, Cr, Al, Na, Ga, Y, Ce, Pr, Nd, Sm, Gd ve Dy (madence steril bölgede) elementlerinin en çok Pürem tarafından bünyeye alındığı, bunun yanısıra Mo, Zn, Ca, Mg, Se ve S'ün maden bölgesinde, Co, Mn ve Cd'un damarların bulunmadığı steril bölgede Söğüt'de daha çok zenginleştiği belirlenmiştir.

Bu verilerin ışığı altında, bitkilere ,elementlerin davranış mekanizmalarına ve çevreye çeşitli bağımlılıklar olmasına rağmen, altın ve gümüş içeren kuvars ve sülfit damarlarının yerlerinin bulunmasında bu bitkilerin rahatlıkla kullanılabileceği belirlenmiştir.

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