porphyry copper mineralization zone adjacent to Namosi might have shown the potassium adding alteration accompanied by porphyry copper mineralization.

The elements of Ba, Cr and V are also controlled by the background values of the geologic units. Cr content is especially high at the area covered by the Verata group.

The elements such as Ag, As, Au, Cd, Cu, Hg, Mo, Pb, S, Sb and Zn are generally accompanied by the porphyry copper and/or hydrothermal mineralization.

The anomalies of Ag, As and Hg dispersed over the area. They indicate local hydrothermal mineralization. The gold anomalies overlaps with the area around a large scale mineral occurrences adjacent to Namosi and the area around gold occurrences to the south of the Nomosi area. Subordinated Au anomalies also disperse in all the area. The Cu anomalies concentrates around the big scale porphyry copper mineralization zone adjacent to Namosi in particular. This copper zone is surrounded by the anomalies of Mo, Pb and Zn. It is generally known that a porphyry type mineralization shows geochemical zonation patterns, including peripheral Pb and Zn mineralization beyond the main Cu-Au-Mo anomaly. The distributions of Pb and Zn are coincident with known zonation patterns. The anomalies of Mo are also detected to the east of the Wainaleka copper occurrence, where a porphyry type mineral occurrence at Echo Creek was located.

(4). Principal Component analysis

The covariance and correlation coefficient matrices are shown in Table 3-2-1. The correlation matrix is equivalent to a covariance matrix for the data where each variable has been standardized to zero mean and unit variance. Principal Component analysis (PCA) was processed by use of this correlation matrix. This method tends to equalize the influence of each variable.

PCA is a technique that attempts to reduce complex data sets consisting of many different variables to a smaller set of new variables that manage to describe the variation in the original data. Percentage of variability was explained by the calculated vector of eigen values of the matrix. Cumulative contribution ratio from the first to third principal component was 42.9%. The distributions of the first (Z-1), second (Z-2) and third (Z-3) component scores are shown in the Fig.3-2-2.

Z-1: The contribution ratio of the first principal component explained 19.4% of the variability. The positive contributed elements are Fe, Co, V, Zn and Mn: the constituents of mafic or opaque minerals, while the negative elements are Na, K and Al: the constituents related to rock forming minerals. This may show the ratio of major rock forming minerals in each geological units.

Z-2: The contribution ratio of the second principal component explained 13.7% of the variability. The positive contributed elements are Mg, Ca, Sr, P and Ni. The area with high scores roughly overlaps with sedimentary rocks, volcaniclastic rocks and volcanic rocks; while the area with negative scores tend to overlap roughly with intrusive rocks.

Z-3: The contribution ratio of the third principal component explained 9.7% of the variability. The positive contributed elements are As, Hg, Cu, Au and S that show geochemical anomalies on porphyry type or hydrothermal mineral occurrences, while the negative elements are Ca and Na. The areas with high scores overlap with the known copper and/or gold mineral indications such as Namosi area, Waimanu, Wainaleka, and so on.

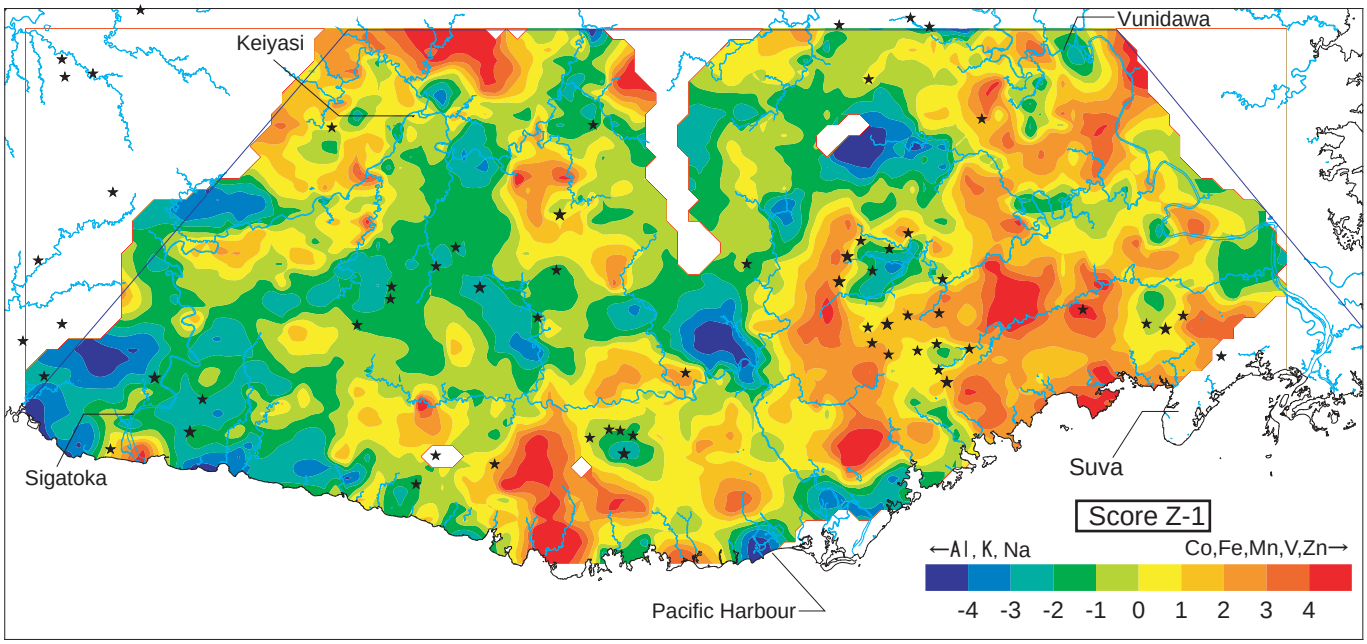
Table 3-2-1. Covariance and correlation coeffcient matrices of the stream sediment samples

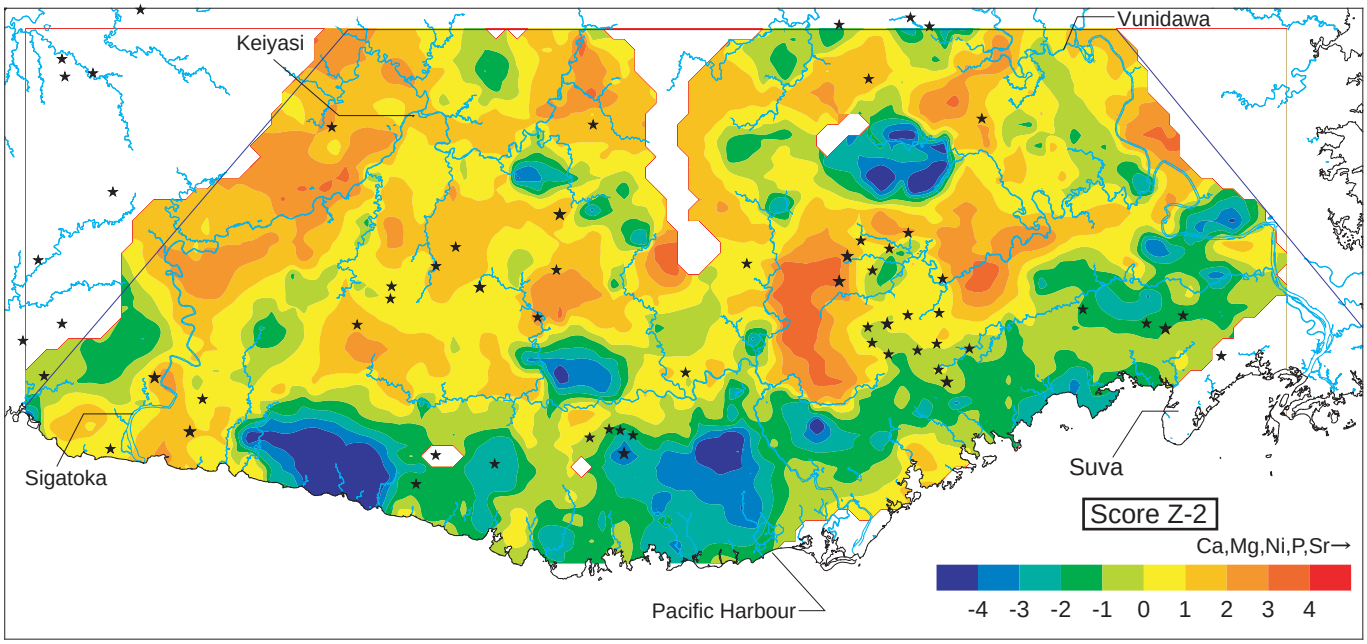
Covariance

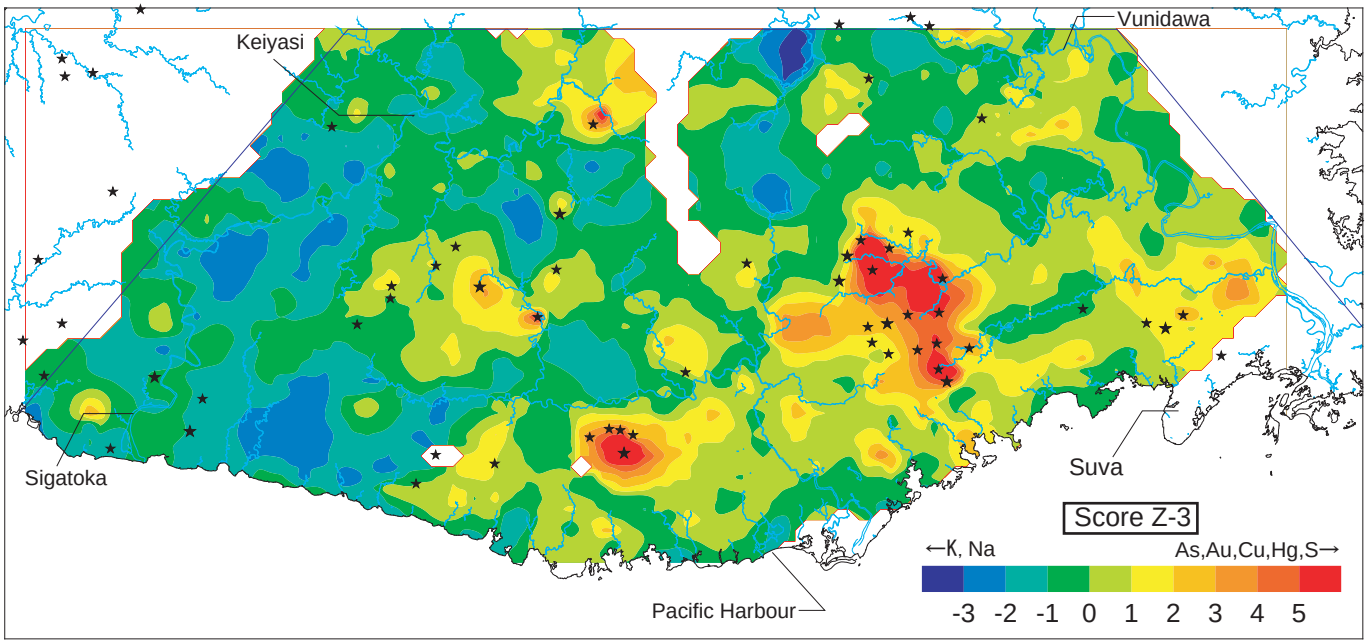
cov_mat	Au	Hg	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sb	Sr	Ti	V	W	Zn
Au	0.511	0.03	0.006	0.002	0.034	0.009	-0.008	0.003	-0.039	0	0.004	-0.009	0.053	0.011	0.011	-0.007	-0.012	0.016	-0.031	0.004	0.007	0.035	0.049	-0.004	-0.018	0.004	0.025	-0.002	0.02
Hg	0.030	0.068	0.000	0.007	0.013	0.007	-0.003	-0.003	-0.032	-0.020	0.000	-0.004	0.026	-0.005	-0.001	-0.009	-0.005	0.000	-0.023	0.002	0.010	0.007	0.022	-0.003	-0.014	-0.001	-0.008	-0.004	0.007
Ag	0.006	0.000	0.005	-0.001	0.001	-0.001	-0.001	0.001	-0.001	0.001	0.002	0.000	0.001	0.002	-0.001	0.000	0.001	0.001	-0.002	0.000	-0.003	0.003	0.002	0.000	-0.003	0.000	0.002	0.000	0.002
Al	0.002	0.007	-0.001	0.015	0.003	0.011	0.007	-0.004	0.008	-0.011	-0.004	-0.005	0.008	-0.012	0.012	0.010	-0.011	-0.005	0.013	0.008	0.049	-0.004	0.017	-0.001	0.022	0.000	-0.010	-0.004	-0.007
As	0.034	0.013	0.001	0.003	0.042	0.010	-0.004	0.006	-0.011	-0.001	-0.002	-0.011	0.019	-0.003	0.009	-0.002	-0.006	0.017	-0.007	0.000	0.026	0.018	0.031	0.001	0.000	-0.001	-0.002	-0.003	0.005
Ba	0.009	0.007	-0.001	0.011	0.010	0.062	0.011	0.002	0.006	-0.023	-0.012	-0.014	0.014	-0.015	0.049	0.005	-0.014	0.006	0.018	-0.004	0.077	0.013	0.028	0.001	0.046	0.003	-0.013	-0.010	-0.010
Be	-0.008	-0.003	-0.001	0.007	-0.004	0.011	0.119	0.003	0.006	0.061	-0.001	-0.002	0.006	-0.009	0.013	0.008	-0.007	-0.019	0.013	0.003	0.062	-0.011	0.017	-0.005	0.009	0.010	-0.005	0.035	-0.007
Bi	0.003	-0.003	0.001	-0.004	0.006	0.002	0.003	0.078	0.002	0.011	0.012	0.002	0.007	0.013	-0.005	0.003	0.007	0.005	-0.007	0.001	-0.009	0.008	-0.012	0.006	0.004	0.002	0.015	0.003	0.013
Ca	-0.039	-0.032	-0.001	0.008	-0.011	0.006	0.006	0.002	0.098	0.019	0.017	0.024	-0.011	0.000	0.007	0.053	-0.003	-0.008	0.053	0.031	0.055	-0.007	-0.001	0.008	0.080	0.007	0.017	0.002	-0.013
Cd	0.000	-0.020	0.001	-0.011	-0.001	-0.023	0.061	0.011	0.019	0.214	0.038	-0.006	0.020	0.028	-0.021	0.024	0.015	0.008	-0.016	0.028	0.012	0.001	-0.017	0.039	-0.033	0.014	0.041	0.066	0.026
Co	0.004	0.000	0.002	-0.004	-0.002	-0.012	-0.001	0.012	0.017	0.038	0.068	0.035	0.049	0.036	-0.022	0.039	0.018	-0.005	-0.028	0.060	-0.026	0.018	-0.025	0.005	0.003	0.008	0.053	0.015	0.037
Cr	-0.009	-0.004	0.000	-0.005	-0.011	-0.014	-0.002	0.002	0.024	-0.006	0.035	0.168	0.012	0.015	-0.009	0.027	0.009	-0.016	-0.003	0.086	-0.041	0.007	-0.024	-0.006	0.010	0.004	0.022	0.002	0.000
Cu	0.053	0.026	0.001	0.008	0.019	0.014	0.006	0.007	-0.011	0.020	0.049	0.012	0.098	0.018	0.000	0.030	-0.001	0.007	-0.037	0.053	0.038	0.031	0.032	0.003	0.009	0.007	0.037	0.007	0.037
Fe	0.011	-0.005	0.002	-0.012	-0.003	-0.015	-0.009	0.013	0.000	0.028	0.036	0.015	0.018	0.043	-0.019	0.009	0.027	0.007	-0.026	0.010	-0.055	0.015	-0.025	0.003	-0.019	0.009	0.049	0.011	0.032
K	0.011	-0.001	-0.001	0.012	0.009	0.049	0.013	-0.005	0.007	-0.021	-0.022	-0.009	0.000	-0.019	0.067	0.005	-0.016	0.002	0.026	-0.012	0.083	0.006	0.031	-0.002	0.044	0.002	-0.018	-0.009	-0.018
Mg	-0.007	-0.009	0.000	0.010	-0.002	0.005	0.008	0.003	0.053	0.024	0.039	0.027	0.030	0.009	0.005	0.061	-0.001	-0.007	0.017	0.053	0.051	0.009	0.006	0.007	0.043	0.007	0.029	0.007	0.010
Mn	-0.012	-0.005	0.001	-0.011	-0.006	-0.014	-0.007	0.007	-0.003	0.015	0.018	0.009	-0.001	0.027	-0.016	-0.001	0.031	0.004	-0.016	-0.002	-0.054	0.009	-0.026	0.002	-0.024	0.004	0.021	0.007	0.024
Mo	0.016	0.000	0.001	-0.005	0.017	0.006	-0.019	0.005	-0.008	0.008	-0.005	-0.016	0.007	0.007	0.002	-0.007	0.004	0.118	-0.004	-0.013	0.016	0.028	0.027	0.013	-0.016	0.002	0.009	-0.005	0.003
Na	-0.031	-0.023	-0.002	0.013	-0.007	0.018	0.013	-0.007	0.053	-0.016	-0.028	-0.003	-0.037	-0.026	0.026	0.017	-0.016	-0.004	0.079	-0.007	0.069	-0.011	0.017	0.002	0.054	0.001	-0.027	-0.007	-0.030
Ni	0.004	0.002	0.000	0.008	0.000	-0.004	0.003	0.001	0.031	0.028	0.060	0.086	0.053	0.010	-0.012	0.053	-0.002	-0.013	-0.007	0.134	0.012	0.020	-0.015	0.005	0.025	0.006	0.032	0.008	0.018
P	0.007	0.010	-0.003	0.049	0.026	0.077	0.062	-0.009	0.055	0.012	-0.026	-0.041	0.038	-0.055	0.083	0.051	-0.054	0.016	0.069	0.012	0.435	-0.002	0.163	0.019	0.114	0.026	-0.024	0.003	-0.047
Pb	0.035	0.007	0.003	-0.004	0.018	0.013	-0.011	0.008	-0.007	0.001	0.018	0.007	0.031	0.015	0.006	0.009	0.009	0.028	-0.011	0.020	-0.002	0.182	0.019	0.014	-0.016	0.001	0.019	-0.001	0.033
S	0.049	0.022	0.002	0.017	0.031	0.028	0.017	-0.012	-0.001	-0.017	-0.025	-0.024	0.032	-0.025	0.031	0.006	-0.026	0.027	0.017	-0.015	0.163	0.019	0.292	0.004	0.027	0.015	-0.011	-0.011	-0.008
Sb	-0.004	-0.003	0.000	-0.001	0.001	0.001	-0.005	0.006	0.008	0.039	0.005	-0.006	0.003	0.003	-0.002	0.007	0.002	0.013	0.002	0.005	0.019	0.014	0.004	0.062	-0.006	0.006	0.008	0.017	0.006
Sr	-0.018	-0.014	-0.003	0.022	0.000	0.046	0.009	0.004	0.080	-0.033	0.003	0.010	0.009	-0.019	0.044	0.043	-0.024	-0.016	0.054	0.025	0.114	-0.016	0.027	-0.006	0.183	0.010	-0.004	-0.024	-0.026
Ti	0.004	-0.001	0.000	0.000	-0.001	0.003	0.010	0.002	0.007	0.014	0.008	0.004	0.007	0.009	0.002	0.007	0.004	0.002	0.001	0.006	0.026	0.001	0.015	0.006	0.010	0.021	0.019	0.006	0.005
V	0.025	-0.008	0.002	-0.010	-0.002	-0.013	-0.005	0.015	0.017	0.041	0.053	0.022	0.037	0.049	-0.018	0.029	0.021	0.009	-0.027	0.032	-0.024	0.019	-0.011	0.008	-0.004	0.019	0.081	0.014	0.034
W	-0.002	-0.004	0.000	-0.004	-0.003	-0.010	0.035	0.003	0.002	0.066	0.015	0.002	0.007	0.011	-0.009	0.007	0.007	-0.005	-0.007	0.008	0.003	-0.001	-0.011	0.017	-0.024	0.006	0.014	0.040	0.008
Zn	0.020	0.007	0.002	-0.007	0.005	-0.010	-0.007	0.013	-0.013	0.026	0.037	0.000	0.037	0.032	-0.018	0.010	0.024	0.003	-0.030	0.018	-0.047	0.033	-0.008	0.006	-0.026	0.005	0.034	0.008	0.055

Correlation coefficient

cor_mat	Au	Hg	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sb	Sr	Ti	V	W	Zn
Au	1	0.160	0.113	0.023	0.231	0.053	-0.030	0.017	-0.176	0.000	0.024	-0.032	0.237	0.077	0.060	-0.037	-0.095	0.066	-0.156	0.014	0.015	0.115	0.127	-0.025	-0.060	0.043	0.124	-0.014	0.121
Hg	0.160	1	0.001	0.207	0.234	0.112	-0.035	-0.038	-0.389	-0.166	0.007	-0.038	0.322	-0.095	-0.014	-0.139	-0.117	-0.005	-0.312	0.025	0.056	0.063	0.159	-0.046	-0.124	-0.019	-0.102	-0.079	0.112
Ag	0.113	0.001	1	-0.134	0.086	-0.073	-0.041	0.028	-0.050	0.038	0.083	0.000	0.051	0.106	-0.068	-0.018	0.050	0.034	-0.101	-0.001	-0.059	0.093	0.055	-0.010	-0.106	-0.033	0.112	-0.009	0.101
Al	0.023	0.207	-0.134	1	0.134	0.361	0.155	-0.102	0.208	-0.189	-0.117	-0.096	0.213	-0.492	0.376	0.341	-0.527	-0.111	0.363	0.173	0.601	-0.076	0.261	-0.029	0.416	0.020	-0.293	-0.167	-0.251
As	0.231	0.234	0.086	0.134	1	0.198	-0.060	0.109	-0.174	-0.013	-0.034	-0.135	0.302	-0.071	0.176	-0.032	-0.166	0.240	-0.124	-0.006	0.190	0.210	0.279	0.019	0.003	-0.028	-0.038	-0.077	0.106
Ba	0.053	0.112	-0.073	0.361	0.198	1	0.125	0.028	0.076	-0.199	-0.192	-0.139	0.183	-0.292	0.762	0.086	-0.311	0.070	0.264	-0.045	0.471	0.118	0.208	0.017	0.433	0.090	-0.186	-0.199	-0.173
Be	-0.030	-0.035	-0.041	0.155	-0.060	0.125	1	0.036	0.059	0.383	-0.007	-0.013	0.054	-0.121	0.141	0.093	-0.111	-0.162	0.138	0.021	0.272	-0.074	0.089	-0.053	0.058	0.199	-0.051	0.500	-0.088
Bi	0.017	-0.038	0.028	-0.102	0.109	0.028	0.036	1	0.025	0.084	0.161	0.016	0.086	0.218	-0.074	0.043	0.139	0.054	-0.084	0.010	-0.051	0.069	-0.080	0.088	0.031	0.038	0.196	0.059	0.195
Ca	-0.176	-0.389	-0.050	0.208	-0.174	0.076	0.059	0.025	1	0.135	0.212	0.190	-0.108	-0.002	0.082	0.682	-0.048	-0.072	0.602	0.270	0.267	-0.049	-0.006	0.108	0.594	0.153	0.193	0.038	-0.182
Cd	0.000	-0.166	0.038	-0.189	-0.013	-0.199	0.383	0.084	0.135	1	0.313	-0.032	0.142	0.289	-0.174	0.214	0.188	0.052	-0.121	0.165	0.039	0.005	-0.066	0.335	-0.169	0.205	0.312	0.710	0.236
Co	0.024	0.007	0.083	-0.117	-0.034	-0.192	-0.007	0.161	0.212	0.313	1	0.330	0.606	0.665	-0.322	0.611	0.385	-0.056	-0.379	0.631	-0.151	0.158	-0.179	0.084	0.028	0.208	0.724	0.281	0.608
Cr	-0.032	-0.038	0.000	-0.096	-0.135	-0.139	-0.013	0.016	0.190	-0.032	0.330	1	0.091	0.175	-0.088	0.262	0.125	-0.112	-0.025	0.570	-0.153	0.039	-0.110	-0.059	0.058	0.059	0.190	0.023	-0.001
Cu	0.237	0.322	0.051	0.213	0.302	0.183	0.054	0.086	-0.108	0.142	0.606	0.091	1	0.279	0.002	0.395	-0.014	0.066	-0.424	0.462	0.184	0.231	0.187	0.042	0.067	0.153	0.413	0.105	0.503
Fe	0.077	-0.095	0.106	-0.492	-0.071	-0.292	-0.121	0.218	-0.002	0.289	0.665	0.175	0.279	1	-0.357	0.172	0.730	0.100	-0.452	0.138	-0.405	0.168	-0.223	0.067	-0.218	0.291	0.828	0.258	0.658
K	0.060	-0.014	-0.068	0.376	0.176	0.762	0.141	-0.074	0.082	-0.174	-0.322	-0.088	0.002	-0.357	1	0.082	-0.348	0.020	0.352	-0.132	0.488	0.052	0.225	-0.025	0.396	0.040	-0.243	-0.175	-0.303
Mg	-0.037	-0.139	-0.018	0.341	-0.032	0.086	0.093	0.043	0.682	0.214	0.611	0.262	0.395	0.172	0.082	1	-0.013	-0.081	0.246	0.581	0.316	0.083	0.044	0.120	0.412	0.207	0.410	0.134	0.180
Mn	-0.095	-0.117	0.050	-0.527	-0.166	-0.311	-0.111	0.139	-0.048	0.188	0.385	0.125	-0.014	0.730	-0.348	-0.013	1	0.058	-0.315	-0.035	-0.464	0.122	-0.276	0.042	-0.316	0.154	0.427	0.196	0.569
Mo	0.066	-0.005	0.034	-0.111	0.240	0.070	-0.162	0.054	-0.072	0.052	-0.056	-0.112	0.066	0.100	0.020	-0.081	0.058	1	-0.039	-0.100	0.069	0.193	0.146	0.157	-0.107	0.043	0.095	-0.077	0.032
Na	-0.156	-0.312	-0.101	0.363	-0.124	0.264	0.138	-0.084	0.602	-0.121	-0.379	-0.025	-0.424	-0.452	0.352	0.246	-0.315	-0.039	1	-0.065	0.372	-0.095	0.112	0.034	0.448	0.023	-0.340	-0.118	-0.463
Ni	0.014	0.025	-0.001	0.173	-0.006	-0.045	0.021	0.010	0.270	0.165	0.631	0.570	0.462	0.138	-0.132	0.581	-0.035	-0.100	-0.065	1	0.050	0.127	-0.075	0.060	0.162	0.104	0.305	0.111	0.213
P	0.015	0.056	-0.059	0.601	0.190	0.471	0.272	-0.051	0.267	0.039	-0.151	-0.153	0.184	-0.405	0.488	0.316	-0.464	0.069	0.372	0.050	1	-0.009	0.458	0.116	0.403	0.275	-0.129	0.026	-0.305
Pb	0.115	0.063	0.093	-0.076	0.210	0.118	-0.074	0.069	-0.049	0.005	0.158	0.039	0.231	0.168	0.052	0.083	0.122	0.193	-0.095	0.127	-0.009	1	0.080	0.134	-0.090	0.009	0.157	-0.014	0.334
S	0.127	0.159	0.055	0.261	0.279	0.208	0.089	-0.080	-0.006	-0.066	-0.179	-0.110	0.187	-0.223	0.225	0.044	-0.276	0.146	0.112	-0.075	0.458	0.080	1	0.027	0.118	0.192	-0.072	-0.099	-0.065
Sb	-0.025	-0.046	-0.010	-0.029	0.019	0.017	-0.053	0.088	0.108	0.335	0.084	-0.059	0.042	0.067	-0.025	0.120	0.042	0.157	0.034	0.060	0.116	0.134	0.027	1	-0.058	0.174	0.107	0.332	0.100
Sr	-0.060	-0.124	-0.106	0.416	0.003	0.433	0.058	0.031	0.594	-0.169	0.028	0.058	0.067	-0.218	0.396	0.412	-0.316	-0.107	0.448	0.162	0.403	-0.090	0.118	-0.058	1	0.154	-0.030	-0.276	-0.264
Ti	0.043	-0.019	-0.033	0.020	-0.028	0.090	0.199	0.038	0.153	0.205	0.208	0.059	0.153	0.291	0.040	0.207	0.154	0.043	0.023	0.104	0.275	0.009	0.192	0.174	0.154	1	0.456	0.194	0.142
V	0.124	-0.102	0.112	-0.293	-0.038	-0.186	-0.051	0.196	0.193	0.312	0.724	0.190	0.413	0.828	-0.243	0.410	0.427	0.095	-0.340	0.305	-0.129	0.157	-0.072	0.107	-0.030	0.456	1	0.241	0.516
W	-0.014	-0.079	-0.009	-0.167	-0.077	-0.199	0.500	0.059	0.038	0.710	0.281	0.023	0.105	0.258	-0.175	0.134	0.196	-0.077	-0.118	0.111	0.026	-0.014	-0.099	0.332	-0.276	0.194	0.241	1	0.176
Zn	0.121	0.112	0.101	-0.251	0.106	-0.173	-0.088	0.195	-0.182	0.236	0.608	-0.001	0.503	0.658	-0.303	0.180	0.569	0.032	-0.463	0.213	-0.305	0.334	-0.065	0.100	-0.264	0.142	0.516	0.176	1







★ Mineral occurrence
Scale 1:700,000

Fig.3-2-2. PCA scores of the stream sediments