A study on mineralogy of soils under two parent rocks in higher rainfall areas of Iran

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Abstract
Morphology, mineralogy and geochemistry of soils derived from granite and andesitic basalt was investigated in western part of Lahijan. Two representative soil pedons were selected in mountain landform. Mineral weathering was characterized by petrographic microscope and comparison was made with total elemental analysis (XRF) and X-ray analysis (XRD).All evidences showed that there is a close structured relationship between the host mineral and the weathering products however, the weathered rock has also been hydrothermally altered. Mineral composition (confirmed by thin section and XRD) in granite were quartz, orthoclase (including perthitizing zone) albitic plagioclase and minor amount of biotite however in andesitic basalt were pyroxene, olivine, amphibole, plagioclase (labradorite) and quartz. Furthermore, sericite, chlorite, smectite (in soils from andesitic basalt) and vermiculite were the most alteration products. Total elemental content of Ca, Mg and Fe as well as solum thickness in field observation and clay mineral content were higher in soils from andesitic basalt which can be attributed to the presence of more susceptible ferromagnesian minerals to weathering.

Key Words
Diffractogram, Crystalline rock, Primary mineral

Introduction
Chemical weathering of rocks is one of the major processes that modify the earth's surface and is one of the vital processes in the geochemical cycling of elements. The rate and nature of chemical weathering vary widely and are controlled by many variables such as parent rock type, topography, climate and biological activity (Islam *et al.* 2002). Petrographic and mineralogical analyses are useful tools for the interpretation of the factors controlling the weathering of crystalline rocks and their influence on the typical development of weathered lanforms. Thus, relations between the parent rock materials and secondary clay minerals can help assist in determining different degrees of weathering (Jimenez-Espinosa *et al.*2007).The present work undertaken in order to characterize the alteration of primary minerals, formation of secondary minerals and their relation with results of geochemical and mineralogical analyses.

Methods
Study area located in Lahijan in north of Iran with annual precipitation of 1200mm, udic soil moisture and thermic soil temperature regime. Two sites of granite (P1) and andesitic basalt (P2) parent material on mountains were selected. Each site consist of one pedon (forest) on shoulder. The studied soil pedons have been characterized by field description bulk and undisturbed sampling, routine physical and chemical analyses, total elemental analyses (Page 1982), X-ray diffraction analyses by XRD and thin sections study by petrographic microscope (Bullock *et al.* 1985).

Results
Mineralogical composition of selected horizons by XRD in two soil profiles are summarized in table 1. The results in soils of P1 showed a dominance of quartz (peak of 3.34 Å), muscovite (10 Å), feldspar (3.18-3.24 Å) and clay minerals (illite) in slightly weathered bedrock (Figure1) and vermiculite, kaolinite and mica in surface and deeper horizons (Ramezanpour *et al.* 2006). Thin sections of this pedon (Table 2) contain mainly quartz, K-feldspar (mostly orthoclase as shown in Figure3b), little amount of plagioclase feldspar (albite) and higher content of muscovite (sericite) together with minor amounts of biotite and chlorite (in Crt1 and Crt2). Geochemical analyses (Table 3) showed the presence of some amounts of Na, K and Fe. Furthermore feldspars to sericite (Figure 3a) and biotite alteration to chlorite was an important process which decreased with depth.

Table 1: Mineralogical composition of selected horizons based on X-ray diffraction

Profile horizons	Minerals				
	Qu	Mu/Il	Ka	Ve	Se
Profile 1(granite)					
A	X	X	X	X	.
Crt2	X	X		X	.
Profile 2(andesitic basalt)					
A	X	.	.	.	X
Bt2	X	X	X	X	.
2Crt2	X	X	.	X	X

Qu= Quartz, Mu/Il= Muscovite/Illite, Ka= Kaolinite, Ve= Vermiculite, Se= Smectite

Table 2. Mineralogical composition of soil pedons based on microscopic observation

Profile horizons	Minerals								
	Qu	FK	Pl	Bi	Mu	Ch	Ol	Px	Am
Profile 1									
A	X	X	X	.	.	.	.	.	.
Crt1	X	X	X	X	X	X	.	.	.
Crt2	X	X	X	X	X	X	.	.	.
Profile 2									
A	X	.	X	.	.	.	X	X	.
Bt1	X	.	X	.	.	.	X	X	X
Bt2	X	.	X	.	.	.	X	X	X
Bt3	X	.	X	.	.	.	X	X	X
Crt1	X	.	.	.	.	X	.	X	.
2Crt2	X	.	X	.	.	.	.	X	.

Qu= Quartz, FK= K-feldspar, Pl= Plagioclase, Bi= Biotite, Mu= Muscovite, Ch= Chlorite, Ol= Olivine, Px= Pyroxene, Am= Amphibole

The XRD patterns of the horizons in P2 showed a composition with a dominance of quartz, muscovite, feldspar, pyroxene (peak of 2.99 Å) and clay minerals in weathered bedrock (Figure2) and smectite, vermiculite, kaolinite and mica in A,Bt2 and Crt2 horizons (Ramezanpour and Zanjanchi 2007).

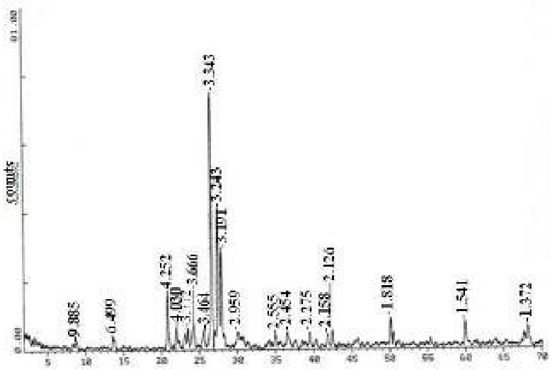

Figure 1. The X-ray diffractograms of the slightly weathered bedrock of P1

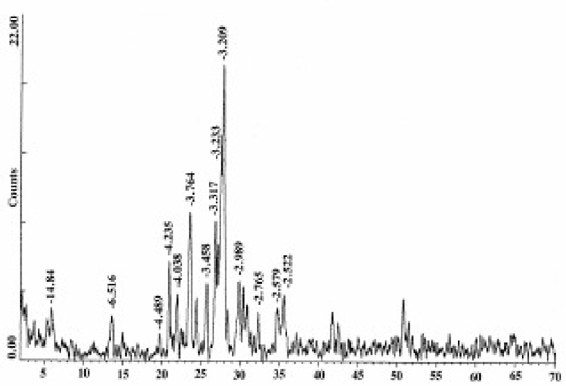

Figure 2. The X-ray diffractograms of the weathered bedrock of P2

Thin section studies revealed that this pedon contain abundant quartz, plagioclase phenocrysts (labradorite), pyroxene, olivine and opaqe minerals. Geochemical analyses showed high amounts of Ca (related to feldspar (labradorite) and mafic minerals) and Mg (is related to mafic minerals) than K and Na in this pedon (Table 3). Alteration of plagioclase to chlorite (Figure 3c,d) and clay minerals as well as pyroxene to amphiboles (Figure 3e, f) was distinc.

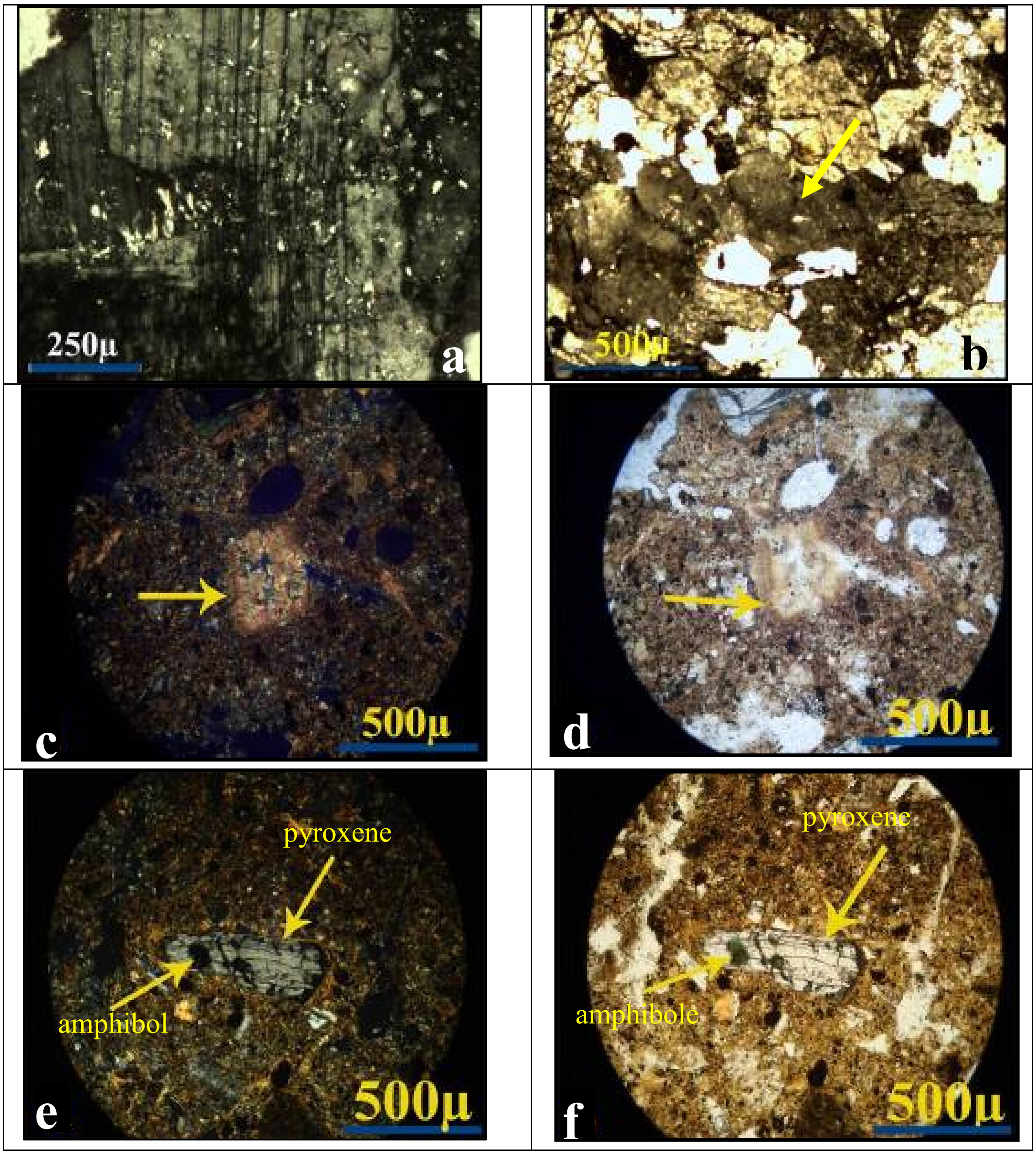

Figure 3: a) Sericitization of plagioclase in Crt horizon from P1- XPL; b) Micrograph of relatively fresh orthoclase in P1-XPL; c) Chlorite pseudomorph after plagioclase in Bt2 horizon from P2- XPL; d) same view in PPL; e) Pyroxene with amphibole as a alteration product in Bt2 horizon from P2- XPL; f) same view in PPL.

Table 3. Total elemental analysis of soil pedons

XRF analyses % Samples	Na_2O	MgO	K_2O	Cao	Fe_2O_3
Profile 1					
A	2.20	0.75	2.51	0.42	2.11
Crt1	1.35	1.81	2.58	0.7	3.84
Crt2	1.61	0.73	2.13	0.37	2.86
Profile 2					
A	0.93	6.05	1.11	3.03	11.24
Bt1	0.71	5.15	1.03	2.78	12.33
Bt2	0.67	5.95	1.29	3.65	11.63
Bt3	1.03	5.22	1.30	2.44	12.94
Crt1	1.16	8.76	0.65	3.57	8.85
2Crt2	0.67	6.11	1.53	3.37	10.06

It can be concluded that most of the clay minerals in soils from two pedons were originated from the presence of weatherable primary minerals. In the study area, however, morphological properties indicated higher solum thickness for andesitic basalt pedon than granite pedon which is further supported by microscopical study and X-ray data.

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