DOI: https://doi.org/10.36719/2707-1146/35/50-55

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GEOCHEMISTRY OF MAGMATIC PROCESSES. FORMATION OF MAGMATISM IN THE EARTH'S CRUST AND THE ROLE OF MAGMA

Abstract

After the Republic of Azerbaijan gained independence, the approach to the concept of "field" has changed. Deposits that were previously considered to be of medium category are currently included in the group of large deposits. Therefore, one of the main issues facing geochemistry and technology in the modern era is to master the areas with a high amount of useful metals that can be considered deposits. For this reason, mineral sciences are closely related to geochemistry, when studying the genesis, age, and stages of formation of ore and non-ore deposits, the methods of isotope geochemistry are widely used. The role of magmatism in the formation of endogenous mineralization is great. Petrochemical series, formations, geochemical types of igneous rocks and certain correlation with endogenous mineralization indicate that magmatism plays a major, and sometimes decisive, role in the formation of endogenous mineralization. Magmatogenic ore deposits associated with sour igneous rocks are formed due to the accumulation of a number of ore elements (lithium, beryllium, niobium, tantalum, rare earth elements, zirconium) in the residual alloy, as they have a low distribution coefficient between crystals and alloy.

Keywords: *mining, geodynamic, mineral, lithology, inorganic, nuclear geology*

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Maqmatik proseslərin geokimyası. Yer qabığında maqmatizmin əmələ gəlməsi və maqmanın rolu

Xülasə

Azərbaycan Respublikası müstəqillik qazandıqdan sonra «yataq» məfhumuna yanaşma dəyişmişdir. Əvvəllər orta kateqoriyalı hesab olunan yataqlar hal-hazırda iri yataqlar qrupuna daxil edilir. Ona görə də müasir dövrdə geokimya və texnologiyanın qarşısında duran əsas məsələlərdən biri hal-hazırda yataq hesab edilə bilən faydalı metalların miqdarı yüksək olan sahələri mənimsəməkdir. Bu səbəbdən faydalı qazıntılar haqqında olan elmlər geokimya ilə sıx əlaqədardır, filiz və qeyri-filiz yataqlarının genezisini, yaşını, formalaşma mərhələlərini öyrəndikdə izotop geokimyasının üsullarından geniş istifadə edilir. Endogen filizləşmənin formalaşmasında maqmatizmin rolu böyükdür. Petrokimyəvi seriyalar, formasiyalar, maqmatik süxurların geokimyəvi tipləri və endogen filizləşmə ilə müəyyən korrelyasiyası endogen filizləşmənin formalaşmasında maqmatizmin böyük, bəzən isə həlledici rol oynamasına dəlalət edir. Turş maqmatik süxurlarla əlaqədar olan maqmatogen filiz yataqları bir sıra filiz elementlərinin (litium, berillium, niobium, tantal, nadir torpaq elementləri, sirkonium) kristallar və ərinti arasındakı aşağı paylanma əmsalına malik olduğu üçün, qalıq ərintidə toplanması hesabına əmələ gəlir.

Açar sözlər: *mədənçilik, geodinamik, mineral, litologiya, qeyri-üzvi, nüvə geologiyası*

Introduction

Geochemistry is a branch of science that describes large geological systems and mechanisms, such as the Earth's crust and oceans, using chemical tools and principles. Geochemistry is a branch of geology. Geochemistry is a science that studies the entire solar system as well as the Earth's mantle convection, the formation of planets and the origin of granite and basalt, including the processes. Geochemistry studies the history of chemical elements in the development of geological processes, their forms of transportation and placement in minerals and rocks. By studying the conditions of accumulation of chemical elements in various geological processes, geochemistry characterizes the physico-chemical conditions of formation of mineral deposits and thus shows the ways of their search. Geochemical search methods of deposits are widely used in geological-exploration works, and by simplifying and cheapening these works, together with geophysical methods, they create a foundation for the search of hidden deposits that do not come to the surface of the eart (Museibov, 2003: 137-138). In the technological assimilation of deposits of a new type of mineral raw material or a new type of ore, geochemistry greatly helps to extract the element. That is, the state of the element subjected to extraction is determined by geochemical methods (is the mineral independent, are the compounds isomorphous and which minerals are involved, etc.). Knowing various chemical and physical methods, using the data of physical chemistry, conducting thermodynamic calculations, geochemistry is able to solve complex problems of the genesis of deposits, especially those that overlap as a result of various geochemical processes. Geochemistry is a complex science. It occupies an intermediate position between geological (mineralogy, petrology, lithology, mineral deposits, hydrogeology, etc.) and chemical (inorganic and physical chemistry, chemical thermodynamics, crystallochemistry, colloid chemistry). Currently, it is impossible to solve petrological and geodynamic problems without geochemistry (At the same time, geochemistry comes into contact with astronomical (cosmogeny, meteoritics), physical (radiogeology, nuclear geology, geophysics), biological (biochemistry, soil science) and geographical (physical geography, landscape science) sciences in the matter of the composition and formation of our planet. to modern information, the source of magma is the mantle is considered and that it is composed of ultrabasic rocks it is assumed (Popova, Bogatikova, 2001: 57-59). Mantle as a whole to fractionation and has undergone little differentiation. Stone meteorites by A.P.Vinogradov for the first time Experiments on zonal melting (of chondrites) and many others chemical elements among dunite, basalt and meteorites data obtained as a result of the distribution show that melting of mantle material actively moving from the mantle and in the process of degassing of mantle material containing chondrites separation into dunite and basalt occurs. If the mantle if we take pyrolite as the initial material (according to A.Ringwood), then As a result of its melting, the substance is peridotite and basalt separation will occur.

The Mohorovicic boundary separating the crust from the mantle 7 km in the oceans, and 30-70 km in the continents (on average 35 km) lies at a depth. The depth of this surface is based on the seismic determined according to lumates. Longitudinal to depth (P-) and transverse (S-) wave propagation velocities straight up to the mantle increases; but in it itself from one place to another both horizontally, also, these velocities vary considerably in the vertical direction. The zone of special importance is from 60 to 250 km located deep. This zone is called low speed zone and first decrease in the speed of S-waves towards the depth, more then characterized by an increase. Slow down zone the substance is probably in a partially melted state and the above is more active than matter. The speed of seismic waves the reduction zone is the generation area of most magmas. This it is proved that, first of all, in these zones, usually the center of earthquakes is grouped. Second, the pressure calculated at this depth corresponds to the formation pressure of the mineral composition of the rocks brought to the surface by the mantle rocks. Of magma the main cause of its formation is considered to be convection (see: Chapter I). Interpretation as the asthenosphere, the low-velocity layer of the Earth and from the more monolithic rocks lying above it consisting of the upper mantle (thickness 0-50 km) and the earth's crust (5-70 km thick) is attributed to the lithosphere. Plate tectonics concept in which plates are viewed as blocks of lithosphere moving relative to the asthenosphere. Usually, the main types of primary magmas correspond to the most widespread rocks in the geological development of the earth is taken. At least three petrographic types of rocks from such magmas are believed to have formed: tholeiitic basalts, alkaline olivine basalts and granitoids of continental batholiths. These magmas its formation and subsequent evolution depend on the composition of the earth's crust and upper mantle (Perelman, Kasimov, 1999: 768). Velocities of transverse and longitudinal waves in the upper mantle, it Calculation of density distribution according to velocities, gravimetric data show that the upper mantle is possible composed of peridotites, eclogites, or intermediates is close to the composition. As we mentioned in the first chapter, the mantle rocks are identified in kimberlites and alkaline basalts and their compositions correspond to peridotites or eclogites. Peridotites are known as olivine, one or the other are ultramafic rocks consisting of several pyroxenes. Eclogites from garnet and clinopyroxene with a composition close to basalts consists of. Thus, Mohorovicič border from basalt and gabbro change of chemical composition to peridotite, or gabbro or basalt (plagioclase+pyroxene) eclogite (pyroxene+garnet) corresponds to isochemical change (Ryabukhin, 2001: 23-24). The phase of eclogites study of the stability and density of the upper mantle evaluation shows that its composition is not eclogite, corresponding to peridotite. In the upper mantle, as in the Earth's crust Lateral inhomogeneity is also observed. How is the primary basaltic magma of the upper mantle formed? Every A proposed hypothesis of what composition of the upper mantle is closely related to the selection. For example, as mentioned above as Green and Ringwood theorized the composition of the upper mantle calculated from three parts harsburgite and one part tholeiitic basalt assumed that it consists of a mixture consisting of pyrolite. O'Khara used the composition of natural garnet peridotite in his model has done. The study of phase equilibria shows that basalt, the generation of magma of each of the above-mentioned substances than one can melt under equilibrium conditions. Formed in this way magmas differ from each other mainly according to the composition of elements they differ. Their during the next fractional crystallization behavior will also differ. Primary mantle magma lying below the Moxo boundary formed as a result of partial melting of peridotites (Liquid phase depleted (depleted) in the upper mantle after separation restite material consisting of peridotites or dunites remains. Restites the main mineral is magnesiumis olivine (Fo~90). So, it's done the incoming alloy will be rich in this mineral and the primary mantle crystallization of magma from magnesium-rich olivine will begin (Mustafabeyli, 1987: 113-121). According to experimental data, olivine (Ol) between the composition and the alloy (m) in equilibrium with the following, there is a dependency: $(Fe^{2+}/Mg)_{Ol}$ / $(Fe^{2+}/Mg)_m=0.3$ Hence Fo90 with $Fe^{2+}/Mg=0.11$ for primary magma containing olivine, iron content $Fe^{2+}/Mg=0.37$ and atomic weight the calculated magnesium coefficient $M=Fe^{2+}/(Fe^{2+}+Mg)=0.73$ must be in equilibrium with the alloy and crystallize from it. These quantities indicate that the primary mantle magma must have responded to a high Mg alloy. In general, at the moment the following constants are assumed for primary mantle magma: KD=0.21-0.36, the content of olivine in equilibrium with the alloy is Fo86- 90, M=0.68-0.75, the content of Ni in olivine is 3000 g/t, in the alloy quantity 200 g/t. The composition of such magmas can be close to picrites, picrobazalts and related rocks. This experiments have confirmed the melting of peridotites. It should be noted that with typical upper mantle mineralogy (olivine+orthopyroxene+clinopyroxene±garnet±spinel) There are primary magmas in equilibrium that are high to magnesium constant (>0.7), high amount of Ni and Cr (respectively >400-500 g/t and >1000 g/t) and not exceeding 50% They have SiO_2 content. It is likely that such rocks were formed from a metasomatized source rather than from the normal mantle they came And metasomatism to partial melting harsburgites (olivine+orthopyroxene) were exposed. Genetic geochemistry is a developing field of geochemistry. He studies the geochemical properties of chemical elements in natural processes, depending on their origin in the earth's crust. According to their origin, chemical elements are divided into several groups: ore-producing – Pb and Co; facial – Sr and B; formation – S and Ni; lithogen – K; tectono-magmatic (tectonic – Mn, magmatic – Pb); deposition (authigen – Sr, allotigen – Ba); metamorphogenic – there are genetic groups characterized by typomorphism of P and Li elements. In coal, shale deposits – N and P, in rare metal deposits – K and Be, in polymetallic deposits – Br and Pb, in iron group elements and bauxite deposits – Mn and V, in salt deposits – Mg and K, in uranium and manganese deposits – Sr and S, in precious stone deposits – elements Li and Be are involved as indicators. The typomorphism of microelement Ag is characteristic (Mehdiyev, 2008: 8-11).

The earth's crust is made up of many igneous rocks and rock-forming minerals. The weathering products of mountain rocks have formed the soil, which is the uppermost fertile layer of the Earth. Soil-forming or parent rocks refer to the upper part of the mountain rocks, which form the mineral base of the soil and on which the soil develops. Without it, soil cannot be formed. The various mountain rocks in the Earth's crust are divided into three major groups according to their origin: igneous, sedimentary, and metamorphic. Igneous rocks are formed from magma at certain depths of the earth and lava that comes to the surface. As a result of the gradual cooling of magma deep in the earth's crust, large crystallized, high-density rocks, that is, intrusive or depth rocks, are formed. These include granite, syenite, diorite, gabbro, etc. Belongs to. As a result of the rapid cooling of lava flows from volcanic eruptions on the surface of the Earth's crust, small crystallized or effusive rocks with a hidden crystalline structure are formed, which are also light in weight. These are basalt, liparite, andesite, perlite, trachyte, pumice, etc. Belongs to. The composition of igneous rocks consists of silica-oxide compounds. The second place is occupied by R2O3 compounds. Of these, those that play an important role in plant nutrition: MqO, CaO, Na2O, K2O, H2O, etc. Although there is enough in the lithosphere, it is mainly in the form of poorly soluble compounds. American scientist F. U. Clark gave the average chemical composition of the lithosphere. The main part (95%) of the Earth's crust is igneous rocks. These rocks are almost covered by soft sedimentary rocks. All sedimentary rocks are divided into three categories: mechanical, chemical and organic sedimentary rocks. Mechanical and clastic sedimentary rocks are formed as a result of mechanical breaking and crushing of mountain rocks. Broken rocks remain in place or are carried to another place by the action of water, wind, ice. Large scraps are those larger than 2 mm in diameter. These include boulders, coarse sand, small river stones, rock, breccia, conglomerate. Those between 2 mm and 0.05 mm in size are called sands or medium-grained sediments. Those with a size between 0.01-0.05 mm are called small flakes. These are dust particles. Typical examples of these rocks are loess and loess-like grains. The more common very fine particles in nature are clayey rocks. In them, the diameter of the particles is smaller than 0.01 mm. It is mainly collected at the bottom of water streams, sea and lake sediments. Clays are yellow, red, gray, black, green. When they dry, they are very hard, and when they are very humid, their volume increases by 40-45%. Sedimentary rocks of chemical origin are rocks formed as a result of chemical reactions and dissolved in water. Examples of these are limestone, rock salt, gypsum, etc. Can be shown. Organic sedimentary rocks are of plant and animal origin. For example, coal. It was formed by carbonization of ancient plants in the Earth's crust. Chalk and limestone are formed by the skeletonization of marine animal remains (Budagov, Shirinov, 2012: 39-50). Metamorphic process is the change of appearance of igneous rocks due to the impact of natural conditions. This process takes place within the earth's crust under conditions of high pressure and temperature. Marble, quartzite, gneiss, crystalline schists are metamorphic rocks. A body with certain physical and chemical properties and formed as a result of natural chemical reactions is called a mineral. In other words, a natural compound with physical and chemical properties in each part is called a mineral. Minerals are formed as a result of physico-chemical processes inside the earth and in water bodies. At present, more than 2000 minerals (not counting their types) are known. As a result of the chemical analysis of minerals in the earth's crust, it was determined that only 9 elements make up 98% of their mass. Acad. According to A. Y. Fersman's calculations, these elements are as follows (%): O-49.19; Si-26.00; Al-7.45; Fe-4,20; Na3.35; Ca-3.25; Mg-2.40; K-2.35; H-1.00. Minerals found in most parts of the earth's crust are quartz, orthoclase, albite, anorthite, mica. Many minerals are important as nutrients for plants. For example, orthoclase contains potassium, anorthite contains calcium, mica contains potassium and magnesium, pyrite contains sulfur, iron and apatite contain phosphorus. Minerals in soil are divided into primary and secondary minerals according to their origin (Balaşov, 1976: 112-

114). The primary minerals are quartz, feldspars, micas, hornblende and pyroxenes. These include the parent rocks that form soil as a result of erosion in the Earth's crust. In soils, these minerals are mainly sand particles (0.05 to 1 mm), dust (0.001 to 0.5 mm), small amounts of silt (less than 0.001), and colloids (less than 0.25 microns). Is in the form of particles. The beginning of the soiling processbegins with wear. A set of complex and diverse processes consisting of quantitative and qualitative changes of mountain rocks and the minerals that make up it under the influence of the atmosphere, hydrosphere and other factors is called weathering. Changing the physical state of rocks without changing their chemical composition is called physical weathering. The erosion process is observed in two zones: Surface (modern wear); Deep (ancient wear). The thickness of the modern weathering crust, where the soil erosion process takes place, varies from 1-2 cm to 2-10 m. Depending on the prevailing factors of the erosion process, they distinguish three forms: physical, chemical and biological. Physical wear is caused by changes in temperature, salts crystallized in frozen water solution, moving water and wind. It is known that each of the minerals that make up the mountain rocks has a coefficient of thermal compression and expansion. For example, the coefficient of thermal expansion of quartz is 0.0000075, 0.000020 in quartz, etc. Therefore, as a result of the daily temperature amplitude, cracks appear in the rocks. Water enters these cracks and when it freezes, it expands and gradually breaks down the rock. This process is also affected by the thermal conductivity of rocks (Voytkevich, Zakrutkin, Osnovi, 1984: 87-89). Due to the influence of the sun, the upper layer of the rock is heated, while the inner part remains as it is. Due to the differences in temperature, the rock is stretched and cracks form from it in the form of a layer or in various forms, the water that enters it freezes, the massive rock in its composition is crushed, and then it undergoes physical wear by rubbing. In the northern regions of Europe, the movement of glaciers in the past led to the fragmentation of rocks. Those materials remained in place of the glaciers. In this way, for example, boulders, sands, red pebbles and clays were formed. Chemical weathering is the chemical change and breakdown of rock and minerals with the formation of new minerals and compounds. The main factor in chemical weathering is atmospheric water, carbon dioxide (CO2) and oxygen. Water is a strong solvent of rock and minerals. It should not be forgotten that the general direction of weathering in nature varies depending on the conditions under which it occurs, especially climatic conditions. Every 100C increase in temperature increases the rate of chemical reaction by 2-2.5 times. It is for this reason that chemical weathering is rapid in the equatorial region, and weak in polar regionsmanifests. Unlike physical wear, chemical wear produces new quality wear products (Imamverdiev, 2003: 425-442). Chemical weathering is more intensive in igneous rocks. Because temperature and pressure are involved in this process. One of the ways of disintegration of mountain rocks under the influence of chemical factors is the way of hydration (combination). Crystals of olivine and other minerals separated from the magma size is usually sufficient for gravitational collapse. This process not only in large chambers, but also in small bodies, for example, basalt it can also go on separate "pillows" of pillow-lavas. Precipitation of crystals with components in crystalline phases becomes impoverished and the composition of the alloy is less than the initial composition differs. From the composition of the primary mantle magma and its P-T depending on the conditions of crystallization, different types of differentials series are formed. Thus, olivine from primary magma, chromspinel, clinopyroxene and high calcium plagioclase of low-alkalinity picrite and picrobazalts by separation differentiation with low-magnesian tholeiitic basalt and gabbroid led to the formation of a finite differentiated series will take out. Moderate, which retains up to 10% of the normative nepheline differentiation of alkaline picrobazalts magmatic alloy composition to trachybasalt-trachytes (monsonite-syenites), high and the differentials of alkaline olivine melanephelinites are phonolite and will end with nepheline syenites (Habibov, 2011: 231-233). At this time, moderate and sodium and potassium in highly alkaline ranges differentiated series are separated. Crystallization differentiation of basic and ultrabasic alloys. At shallow depths as it accompanies its emergence to the surface not the crystallization products of primary mantle magma, but their differentials formed at a shallow depth are widespread. So differentials include low-magnesium tholeiitic basalts, inter-trappean and other continental magmatics Quartz tholeiites, which are widespread in associations, belong to them. To 8% oceanic basalts composed of olivine tholeiites containing up to MgO as a result of the differentiation of olivine and other minerals formed and from the original composition with more magnesium they differ. It is for this reason that low-magnesium tholeiite. In basalts, mantle-type depth inclusions are involved doesn't. Such depth inclusions magnesium-rich alkali in olivine basalts and others with compositions close to primary magmas stored in silica-unsaturated rocks. Fractional crystallization theory most petrologists adopted by and many geochemical, mathematical has been confirmed by models (FC-model). Thus, crystallization differentiation of igneous rocks It is one of the most important petrogenetic processes determining its diversity. Other mechanisms of differentiation play a secondary role playing and spreading in local parts, to happen under favorable conditions know (Mustafabayli, 2019: 213).

Conclusion

Magmatic processes of magmatic hearth temperature it happens by falling down. In this regard, magma reactions change continuously and this change in the composition of rocks that are the end product of crystallization and is reflected in its structure. A variety of igneous rocks types of primary homogeneous magma during crystallization chemically, it is divided into heterogeneous parts. This the process is called magma differentiation and is still used in petrology and is one of the leading problems of geochemistry.

References

1. Museibov, M.A. (2003). Landscapes of the Azerbaijan Republic. Baku: BGU, p.137-138.
2. Petrography and petrology magmatic, metamorphic cheskikh i metasomaticheskikh cornikh porod. (2001). Pod editor V.S.Popova, O.A.Bogatikova, p.57-59.
3. Perelman, A.I., Kasimov, N.S. (1999). Geochemistry of the landscape. Proc. Settlement, Moscow: Astrea, 768 p.
4. Ryabukhin, A.G. (2001). Ecological geochemistry: from the past to the future; from practice to theory. M.: MGU, p.23-24.
5. Mustafabeyli, H. (1987). Geochemical features of early osinclinal sedimentary rocks of the Eastern Caucasus. Lithology and fossils. № 2. p.113-121.
6. Mehdiyev, Sh.F. (2008). General Geology. Baku, p.8-11.
7. Budagov, B.A., Shirinov, N.Sh. (2012). General Geology. Baku, p.39-50.
8. Balashov, O.A. (1976). Geokhimiya redkozemelyonnnikh glementov, s.112-114.
9. Voytkevich, G.V., Zakrutkin, V.V. (1984). Osnovi geokhimii, p.87-89.
10. Imamverdiev, N.A. (2003). Geokhimi redkozemelyonikh glementov Late Cainozoic Volcanic Series Malog Kavkaza. Chemistry. № 4, p.425-442.
11. Habibov, T.C. (2011). General Geology. Baku, p.231-233.
12. Mustafabayli, H.A. (2019). Concise glossary of landscape science terms. Sheki: "Kaskad MMC", 213 p.

Received: 23.06.2023 Accepted: 29.07.2023