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URANIUM-THORIUM MINERALIZATION AND ALBITIZATION (A GEOCHEMICAL NOTE)

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ABSTRACT

This work sheds some light on the relation between albite-bearing or alkaline rocks and U—Th anomaly. Various local and international examples are given. The chemical basis for this association is briefly outlined. Rocks tending to show a trend of albitization or a trend of alkalinity should receive intensive prospection program for U and Th.

INTRODUCTION

The geochemistry of U has been so long known to be controlled mainly by the oxidation of U to the hexavalent mobile state or reduction to the precipitating tetravalent state [GOLDSCHMIDT, 1962]. On the other hand, there is certain crystallochemical and geochemical relationships between uranium and thorium. The present investigation shows the importance of the albitization process in igneous and metamorphic environments as a medium of U-Th mobility and concentration. Thus the albitization process is connected in many cases with U-Th mineralization. This fact is of equal importance in the geochemistry of the two elements particularly U as the fact of the latter's oxidation and reduction and should receive much more attention by U-Th explorers.

EXAMPLES ON ANOMALOUS ALBITE-BEARING ROCKS

Seven examples are given here to illustrate the association of albite-bearing igneous and metamorphic rocks with U and Th anomalies. These include both local and international cases.

1) *Abu Garadi locality:* The most outsanding example comes from Abu Garadi locality of the Eastern Desert of Egypt [EL SOKKARY, 1970]. A suite of samples from Abu Garadi locality was chemically analysed and was analysed as well for U and Th. It was found that changes in the contents of Na_2O and K_2O reflect clearly changes in modal analysis. Na_2O is enriched in certain samples of the suite while K_2O drops out in the same samples. This process of increase of Na_2O with a consequent reduction in K_2O is related to a process of albitization. Again the albitized samples show considerable enrichment in U and Th (up to 186 and 1253 ppm, respectively).

2) *Wadi El Atshan locality:* ABDEL GAWAD [1964] mentioned the case of some volcanic rocks occurring in the Eastern Desert of Egypt which carry uranium mineralization. He says that the volcanic rocks are of two distinctive types, acidic por-

phyries with no associated mineralization and alkaline bostonites which were found to be favourable host rocks for uranium. These bostonites exemplified by the type locality at Wadi El Atshan are intruded in metasediments of the Hammamat series of Upper Algonkian age.

Essential minerals composing these bostonites are sodic feldspar (albite) and orthoclase together making 80 per cent of the rock. Albite with very fine polysynthetic twinning prevails in the groundmass but orthoclase (sanidine) occurs both as microphenocrysts and in the groundmass. The predominance of albite is shown by optical and X-ray diffraction studies.

3) *Abu Rusheid locality:* Another important example is Abu Rusheid locality of the south Eastern Desert of Egypt [SABET, *et al.*, 1976]. Abu Rusheid has contents amounting to 0.02 % Ta_2O_5 and 0.14% Nb_2O_5, respectively. The tantalum-niobium mineralization is associated with Sn, Li, Zr, U (up to 0.80%) and Th (up to 1.43%). The mineralization is located in a sill-like body of albitized and amazonitized granite called apogranite intruded along the contact of the schist and gneiss of the Hafafit series.

4) *The White Mountain locality:* LARSEN and PHAIR [1957] believed that the Southern California batholith contains about the average amount of uranium for batholithic rocks in general. By way of contrast, the Carboniferous White Mountain rocks in New England contain on the average about twice as much uranium as do the comparable rocks from the Southern California batholith. The White Mountain rocks are, however, more sodic than their western counterparts, and underlie a very much smaller area.

5) *Three more international localities:* LARSEN and PHAIR [1957] stated that nearly all samples of alkali granite end syenite tested to date exceed the average uranium and thorium content of calc-alkalic granite not uncommonly by a several-fold factor. All three most radioactive rocks so far reported are alkalic granites *e.g.* the albite granite from Nigeria gives an average U content 130 ppm, the quartz bostonite from Colorado gives 33 ppm U while the Conway biotite granite from New Hampshire yields 9 ppm U.

All three are the silicic end members of predominantly sodic series, the intermediate members of which are monzonites and syenites. All three rocks contain aboundant albite, but in addition to phenocryst of high temperature alkali feldspar, potash-rich cryptoperthite is common in the quartz bostonite. The highly radioactive quartz bostonites from the Colorado Front Range belong to a predominantly sodic series.

RELATION BETWEEN ALKALINITY AND URANIUM MOBILITY

GOLDSCHMIDT [1962] found that in neutral or slightly alkaline solutions uranate ions are also present in increasing proportion with increasing alkalinity. KRAUSKOPF [1967, p. 526] on discussing oxidation of uranium ores mentioned that uranyl hydroxide is slightly soluble in alkaline solutions as well as in acid, solubilities become appreciable only in strongly alkaline solutions.

The same author concluded from the Eh-pH diagram for uranium and vanadium compounds at 25°C and 1 atm. total pressure, that at both sides of the diagram (pH from 0—2 and pH from 12—14 *i.e.* at both the acid and alkaline sides) uranium shows a total solubility exceeding 10^{-4} M, on the acid side taking the form chiefly of uranyl ion and on the alkaline side appearing chiefly in the carbonate complexes.

There is no doubt that alkaline media enhance the solubility and mobility of the uranium ions. It is understood that the albitization process which is connected mainly with the mobilization of Na^{+} ions under water vapor pressure provide the alkaline medium suitable for U wandering. Since the geochemistry of uranium particularly the quadrivalent state has much in common with the geochemistry of Th, it is expected that the same alkaline media are suitable as well for Th mobility. This explains the chemical basis for the association of albitized rocks with U-Th anomaly.

CONCLUSION

It is thus plausible to say that albitization in igneous and metamorphic environments tends to be always associated with U-Th anomaly. This fact can find wide application during geochemical prospection or in areas which are studied geochemically in a sense that whenever the chemistry of rocks shows a trend of albitization, then these rocks might be favourable sites for U and/or Th concentrations and they should receive intensive prospection program because it may lead finally to the discovery of U or Th ores.

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