

Cachoeira Uranium Deposit, Lagoa Real, Bahia, Brazil –kinematic, compositional and fluid evolution

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The Cachoeira uranium albitite-type deposit occurs in a steep dip shear zone aligned with several other similar uranium deposits in the Lagoa Real Province. Uranium resources are estimated as about 90 000 tons U₃O₈ grading 2500 ppm U₃O₈. Uraniferous albitite occupies a 15m-thick strongly mylonitized shear zone structurally enclosed within “zebra”biotite gneiss. Uranium albitite mineralization forms cigar-shaped (prolate) and secondarily pancake-shaped (oblate) bodies composed of albite-hornblende-garnet-uraninite-magnetite ore grading to quartz-free skarn-type rock with fluorite-kyanite-calcite-quartz concordant veins and pockets formed by late hydrothermal process. Brown chalcedony was the latest mineral to form. Fine-grained, disseminated uraninite is distributed and concentrated in the mafic portions of the gneiss consisting of hornblende-andradite-sphene-apatite-epidote forming 30% and albite portions consisting of 70% of the albitite, which allows its gravitational treatment, thus decreasing acid leaching. While the host rock was severely affected by K-metasomatism the uraninite zone was deposited together with hornblende by Na- and Ca-metasomatism according to the reaction: (NaAlSi₃O₈-CaAl₂Si₂O₈) + 2CaMgSi₂O₆ + UO₂Cl₊+3SiO₂+ 2 H₂O + Na₊ + Ca₂₊₊ 3O₂ + 2Fe₃O₄ = UO₂ + 2NaCa₂MgFe₃Al₃Si₆O₂₂(OH)₂ + NaCl or plagioclase + pyroxene + Q+fluid+magnetite+2H₂O +Na₊+Ca₂₊₊3O₂ + Fe₃O₄ = uraninite+hornblende+NaCl. Other reaction involves garnet crystallization exclusively together with uraninite: (NaAlSi₃O₈-CaAl₂Si₂O₈) + UO₂Cl₊+ 2CaMgSi₂O₆ + Fe₃O₄ = NaCa₂MgFe₃Al₃Si₆O₂₂(OH)₂ + UO₂ +4SiO₂+NaCl +12O₂, or plagioclase + pyroxene +UO₂Cl₊+ Fe₃O₄= andradite + uraninite +4Q+ Mg₂₊ +12 O₂ + NaCl which liberates silica and oxygen, differently from previous reaction which consumes silica and oxygen. Both reactions involve magnetite. The destabilization of biotite at the ore zone implies in the formation of GSPO-biotite overgrowing the LPO-biotite previously formed at host rock, due to the excess of K in the system. Textural evidence support the reaction: (CaAl₂Si₂O₈)-NaAlSi₃O₈ + KFe₃AlSi₃O₁₀(OH)₂ + CaMgSi₂O₆ + UO₂Cl₊+Ca₂₊₊= NaCa₂MgFe₃Al₃Si₆O₂₂(OH)₂ + UO₂ + ½ kyanite + 1.5Q + 8¼O₂ + K+ noticing that magnetite is absent. Reaction represents the K-metasomatism at the host zebra gneiss: biotite+plagioclase+pyroxene + UO₂Cl₊ +Ca₂₊₊= hornblende +uraninite+ kyanite+ quartz. The excess of Ca is allocated in the sphene, apatite and epidote structures. Consumption of Ca results in rutile deposition. As fluid composition was complex F and CO₂ were enriched in the system, after main metamorphism/metasomatism occurred. Consequently hydrothermal process dominated the system, resulting in the formation of fluorite, calcite and an excess of silica as brown chalcedony. Uranium minerals also formed, as secondary phosphate, hydro-silicates, hydrated oxides and pechblende, under lower temperature conditions. In a still Ca-rich system sphene and brannerite, together with late calcite could form: FeOTiO₂ +Ca +UO₂ + SiO₂ = CaTiSiO₅ + (Ca,U)(Ti,Fe)₂O₆ (brannerite), marking destabilization of primary ilmenite and uraninite formed in metasomatic stage. Formation of fluorite and calcite corresponds to the next hydrothermal episode: UF₆+CaTiSiO₅ = CaF₂+TiO₂+SiO₂+ pechblende. Brannerite is also destabilized in favor of calcite, rutile, pechblende and hematite under higher oxygen fugacity condition: (Ca,U)(Ti,Fe)₂O₂ + CO₂ +O₂ = CaCO₃ + TiO₂ + Fe₂O₃ + pichblende, the excess of silica formed chalcedony.

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