Serviço Geológico do Brasil

Mineral distribution in the Nb- and REE-rich ferruginous lateritic crust of Seis Lagos Deposits.

SimeXmin – VII Simpósio Brasileiro de Exploração Mineral / VII Brazilian Symposium on Mineral Exploration

Lucy TAKEHARA; Margarete Wagner SIMAS; Andrea SANDER; Marcelo Lacerda VASQUEZ; Marcelo Esteves ALMEIDA; Francisco Valdir SILVEIRA (francisco.silveira@cprm.gov.br

INTRODUCTION

The Seis Lagos Deposit is located in the São Gabriel da Cachoeira, northeastern of Amazonas State (**Figure 1A**), cutting the basement rocks of the Imeri Domain - 1,81 a 1,79 Ga (**Figure 1B**) (ALMEIDA et al., 2011). This deposit is one of largest Nb-deposits in the world formed due to weathering of SiO_2-undersaturated alkaline rocks (siderite carbonatite) (**Figure 1C**). It is a 5 km diameter, circular structure outcropping in the NW Amazon region constituted by an expressive at least 200 meter-thick ferruginous lateritic crust. Drill hole description, petrography, chemistry and x-ray diffractometry of the lateritic crust profile has been conducted to characterize its mineral assemblage and main processes of element mobilization and accumulation.

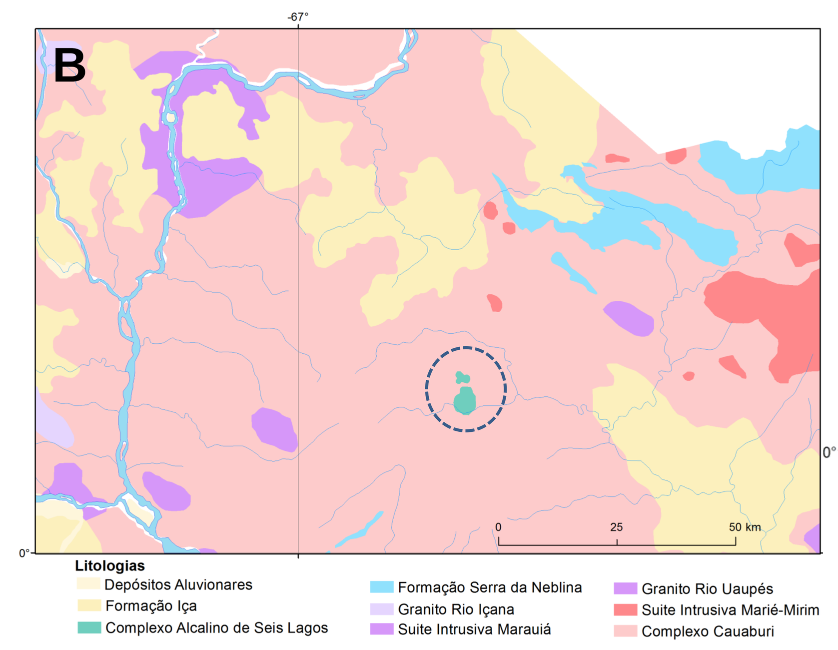

Figure 1 – Morro dos Seis Lagos deposit: (A) Location map; (B) Simplified Geological Map, Seis Lagos alkaline rocks is marked by black circle, and (C) Google Earth image of the Morro dos Seis Lagos deposit.

MATERIALS AND METHODS

The drill hole nº 1 from Seis Lagos Project (VIEGAS FILHO & BONOW, 1976) was used to study the mineralogy of the ferruginous lateritic crust of the Seis Lagos Deposit. The minerals composition were determined by using: (1) Olympus optical microscope with natural and reflected light; (2) PANalytical X-ray diffractometer of X´PERT PRO MPD model with copper anode and 40kV and 40 mA with 5° to 70° scanned angle and step of 0.02° from Lamin-MA da SUREG-MA/CPRM; and (3) Scanning Electron Microscope FEI model LS15 witn energy dispersive spectrometer (EDS) (WD 8,5 mm, 20 kV e 330 - 400 pA) and backscattered electrons images (BSE) (WD 8,5 mm, 20 kV e 70 - 90 pA) from Lamin-BE da SUREG-BE/CPRM and FEI model QUANTA 450 (UnB/CPRM) (20 kV and 10 nA), both equipment with tungsten filament.

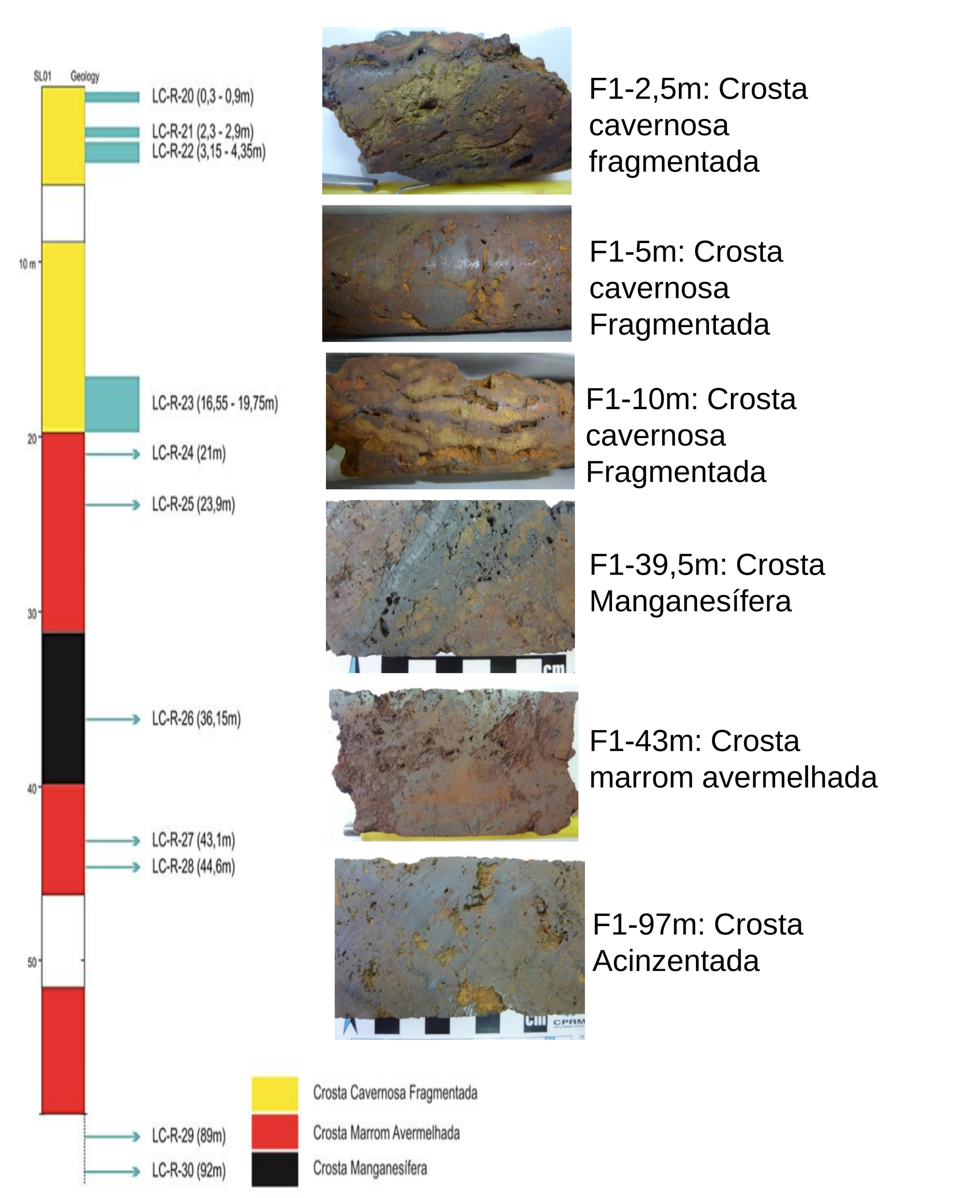

Figure 2 – Different layers of the ferruginous lateritic profile of Seis Lagos deposit divided into according to their structures and textures.

RESULTS AND DISCUSSIONS

The ferruginous lateritic profile of Seis Lagos deposit has more then 200 m of thickness (**Figure 2**) and can be divided into different layers according to their structures and textures, which reflects an active supergene process. The drill hole lateritic profile can be roughly divided into three parts, in the upper, intermediate and lower ones. The lower part is composed by compact ferruginous crust, the intermediate part by a manganese layer situated at 30 to 40 m below the surface, and the upper part formed by porous ferruginous layer with oolitic and brecciated textures. These variations were probably influenced by the movement of meteoric and ground water. In the upper part, the ferruginous lateritic crust shows a porous pisolitic, fragmented and mottled aspects (**Figure 2**) with secondary minerals as niobian rutile, ilmenorutile, anatase, florencite and monazite, whereas in the lower part has a more compact aspect with niobian rutile and cerianite as secondary minerals. However, the goethite and hematite are the main minerals in this lateritic profile, the goethite can be massive and/or porous (**Figure 3**) and acicular (**Figure 4**). The goethite can have some Al in its composition (**Figure 3**), probably due the sample is close to surface. Titanium and niobium elements are well correlated with higher concentration (about 5% and 2% on average, respectively) in the upper part of the profile, while in the lower part the concentration range up to 1.5% Ti and 1.0% Nb and can have iron (**Figure 5**) or REE (**Figure 6**) in their composition. In the manganese-rich layer these both elements are lower than 0.5%. The Nb-Ti minerals like Nb-rutile and ilmenorutile are partially to highly altered and whose elements are embedded the iron minerals (**Figure 7**). These minerals occur as large minerals or cluster of small crystals and as tiny minerals distributed in the ferruginous matrix. The anatase is also present in the uppermost part of the profile as a secondary titanium mineral, formed during supergene process. The higher concentration of rare earth elements, mainly as cerium, phosphorous and aluminum in the upper part of the lateritic profile can be related to florencite and monazite minerals (**Figure 5**). The former mineral is secondary ones and is filling pores, whereas the latter mineral occurs as primary mineral. The advanced alteration process leads to very porous monazite, which it is also found filling pores as acicular minerals (rhabdophane?). Cerianite has been found like tiny acicular crystals aggregates filling fractures and cavities, recognized on the top of manganese-rich layer until to bottom of the drill hole.

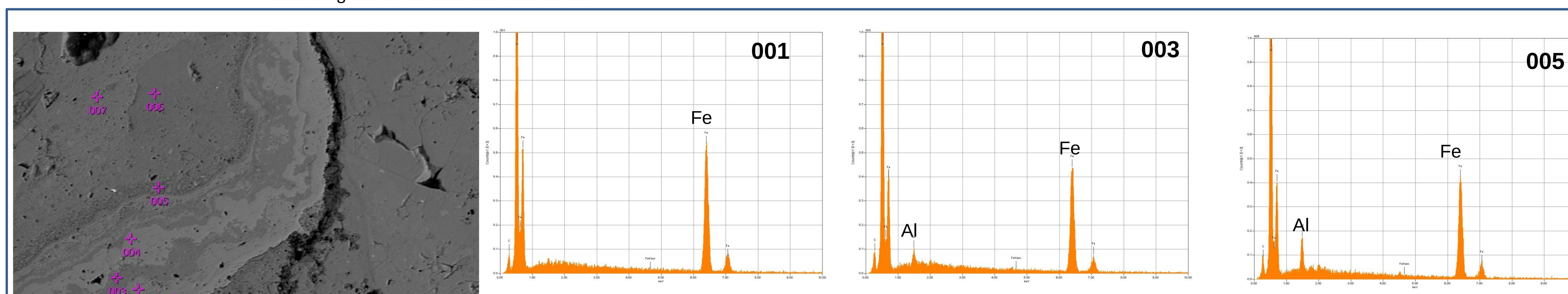

Figure 3 – Goethite mineral shows massive zoned and porous texture from sample LCR-20 (0.3 to 0.6 m of depth). The points on the BSE images are the EDS spectrum, presented on the right side. (SEM images from UnB/CPRM)

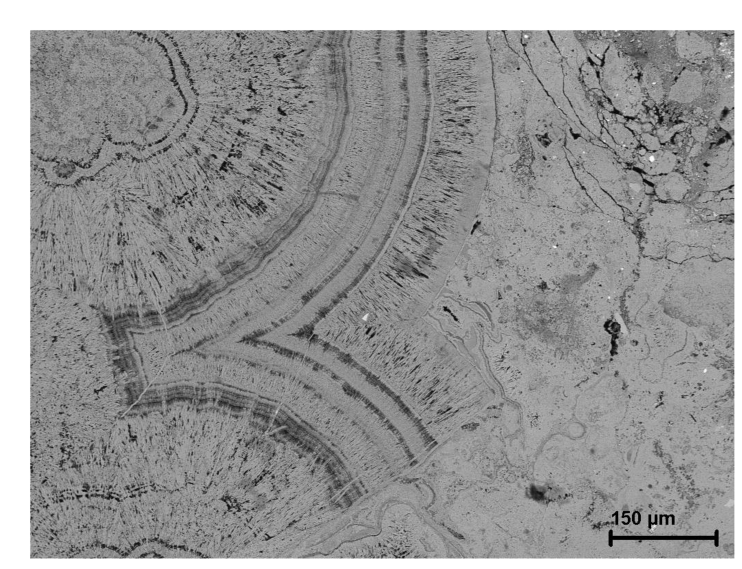

Figure 4 – Acicular goethite mineral with zoning crystallization. (SEM images from Lamin- BE) .

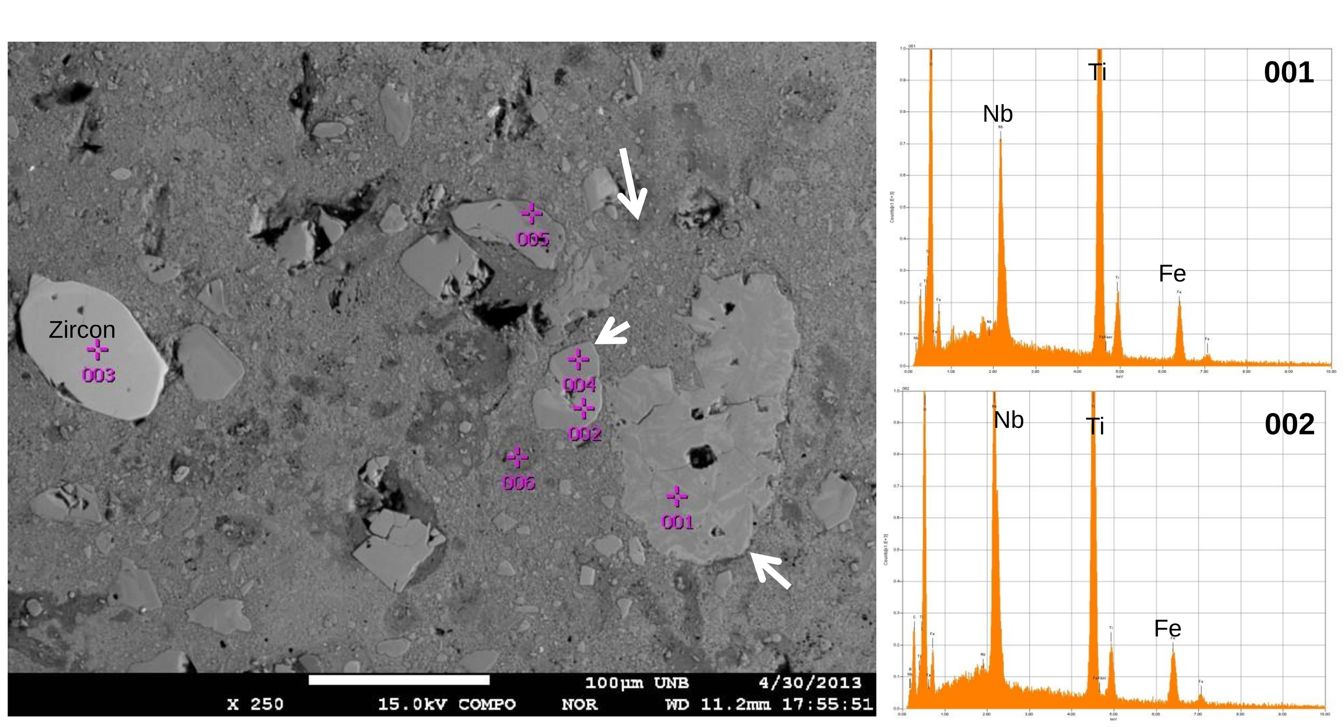

Figure 4 – Niobium and titanium minerals show latticed texture (as can be seen in the minerals pointed by the arrow), the light grey part has higher content of Nb (point 002) compared to grey part with higher content of Ti (point 001). These Nb and Ti minerals has iron in their composition (points 1, 2 and 4), could be ilmenorutile(?). These minerals are contoured by porous iron minerals from sample LCR-21 (2.3 to 2.9 m of depth). The points on the BSE images are the EDS spectrum, presented on the right side. (SEM images from UnB/CPRM)

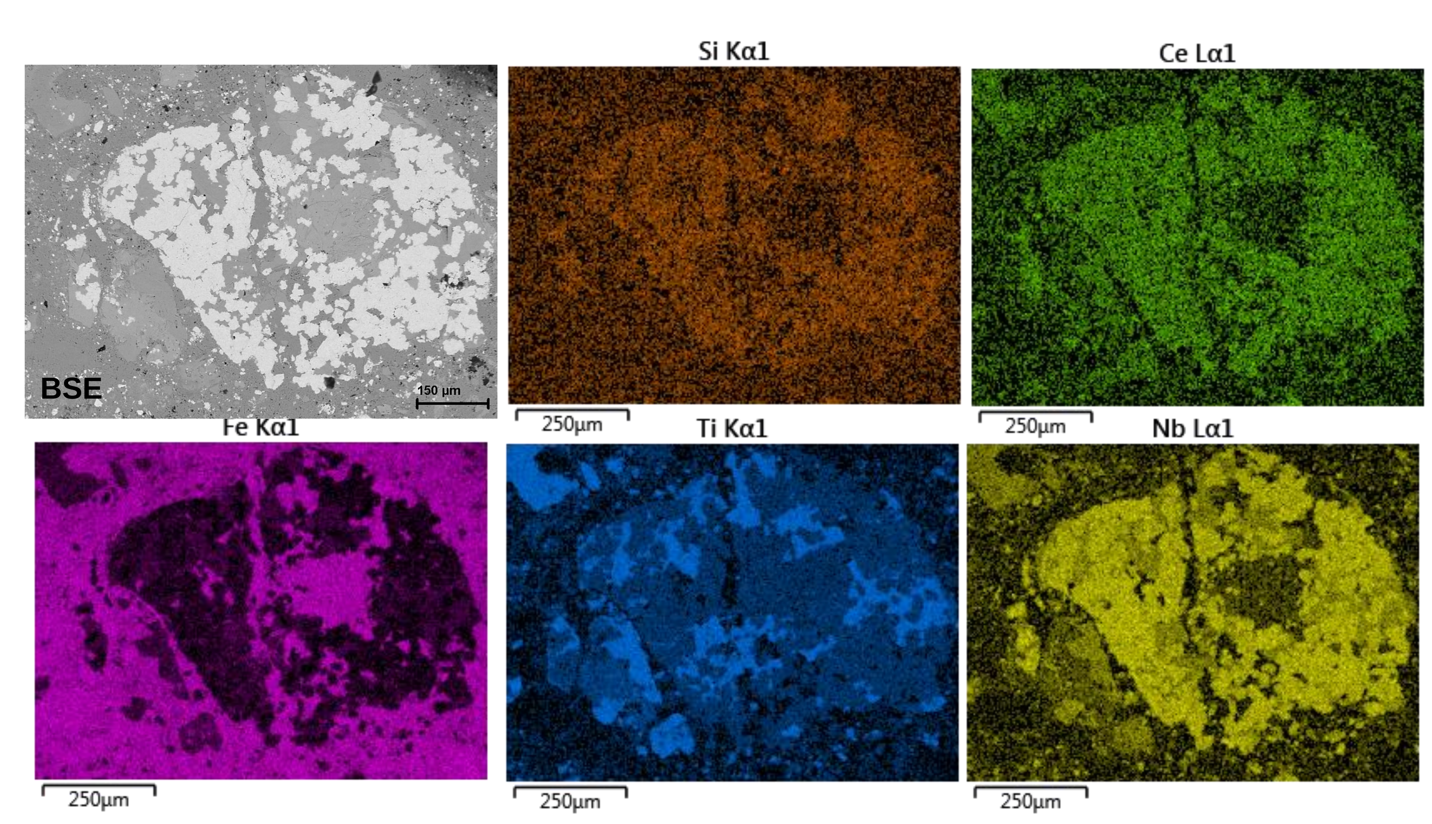

Figure 5 – X-ray maps of niobium and titanium mineral. (SEM images from Lamin- BE)

CONCLUSIONS

The ferruginous lateritic profile of Seis Lagos deposit are mainly composed by iron minerals. However the secondary minerals show a quite variable elemental composition, some of the Nb and Ti minerals have REE and/or Fe in their composition.

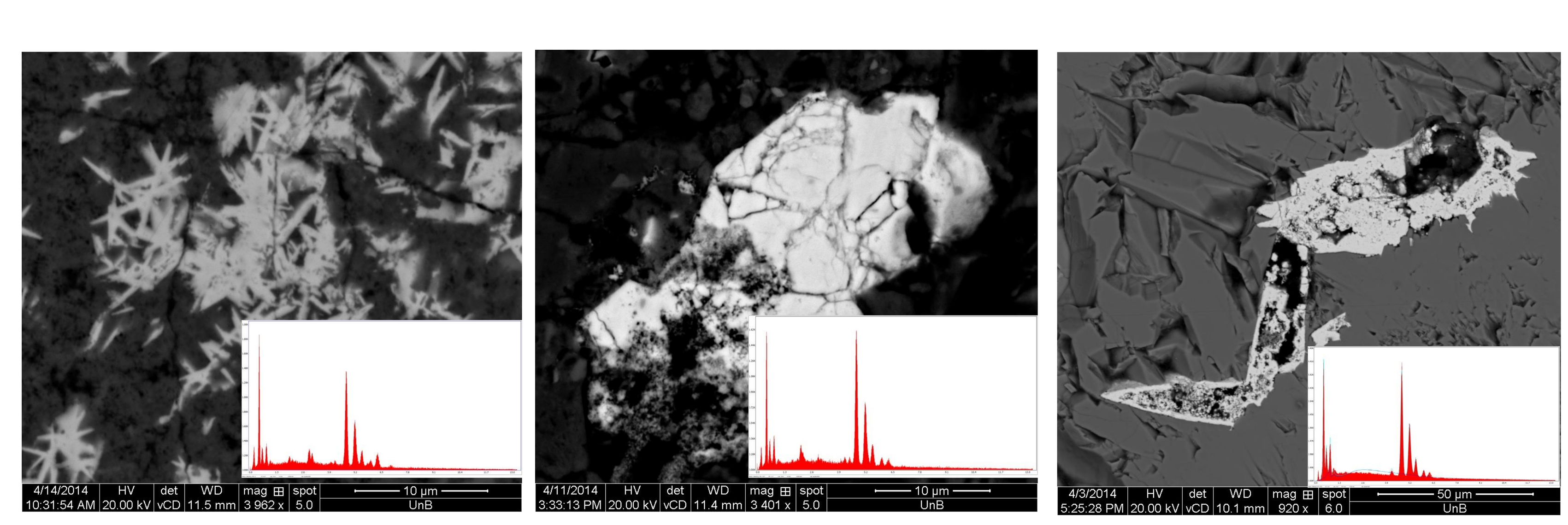

Figure 5 – REE minerals from Seis Lagos lateritic crust. (a) Rabdophane (?) at LCR-26 (36.15 m of depth); (b) Monazite and (c) cerianite at LCR-29 (89.0 m of depth). (SEM images from UnB/CPRM)

REFERÊNCIAS

ALMEIDA, M.A. et al. Folha Serra Imeri NA.20-Y, SA.20-V e V-B. Capitulo 2. Contexto Geológico regional. Projeto Programa Levantamentos Geológicos Básicos do Brasil (PLGB), SUREG-MA, Manaus, p. 7-19, 2011.

VIEGAS FILHO, J.R.; BONOW, C.W. Projeto Seis Lagos. CPRM - SUREG-MA, Relatório Final, 212 p., 1976.