Regional zoning in the Pegmatites of the Oriental Pegmatite Province of Minas Gerais, Brazil

F. R. M. PIRES[1], M. A. FONSECA[2] & M. ECHTERNARCH[1]

[1] Federal University of Rio de Janeiro, frpires@geologia.ufrj.br
[2] Federal University of Ouro Preto, marco@degeo.ufop.br

ABSTRACT

The pegmatites from the Oriental Province of Minas Gerais are characterized by the gem qualities and contents. Apparently the pegmatites are related to the numerous Proterozoic granites, granodiorites and tonalites intruding schists, gneisses, migmatites and charnockites. The granites may be grouped into an anorogenic type and and a syn- to late-kinematic type. Mineralizations follow distinct trends according to the F-, B- and Li-contents in the fluids, Al/Si ratio, Na-K contents and Be-contents. These trends define a regional zoning for the mineralization in the Province.

Keywords: *Granitic Pegmatites Zonings, pegmatite mineralization, Oriental Pegmatite Province.*

The gem province named as Oriental Province of Pegmatite of Minas Gerais, known since the beginning of the 18th century, is famous by its aquamarine, tourmaline and collection specimens. 150 different phosphate minerals have been described from the pegmatites. The pegmatite province which is about 850-km long, mostly in Minas Gerais, extends into the southern part of the Bahia. The purpose of this presentation is to bring attention for the distribution of the pegmatites, its probable relationships with the granites and the apparent mineralogical and geochemical zoning.

Geological formations as well as the mineralizations appear to be controlled along a general north-south trend dominated by the Araçuai Belt at the center portion and several parallel bets, here proposed, distributed from west to east: 1.Espinhaço Belt, which corresponds to a sequence of Proterozoic quartzites and diamondiferous meta-conglomerates, bounded by strong westward thrust sheets. These thrusts brought up a complex lithological assemblage formed by gneisses, schists, greenstone belt remnants, BIF, gondites, dolomites, and quartzites, along with sheared and non deformed intrusive granites. 2. Amethyst Belt, spread out from Bahia State to Minas Gerais. 3. Emerald Belt, corresponding to the discontinuous distribution of phlogopitic and amphibolitic mafic schists with meta-ultrabasic remnants, and corundum-sapphire-bearing schists, with alexandrite deposits, intruded by Early Proterozoic granites, known also as Itabira-Ferros pegmatite belt. 4. Granite or Pegmatite Belt, with migmatites, meta-ultrabasic rocks and biotite schist, as roof pendants, which may be subdivided into a mica belt and a feldspar belt. The mica belt may be intermingled with the emerald belt, due to the deformation and numerous granite intrusions. In this belt are concentrated the majority of the gem and phosphate pegmatites.

The Neoproterozoic granites occupy the central portion of the Province, in a zone approximately between the high grade gneisses and charnockitic migmatites to the east, and the Araçuaí schist belt to the west. These granites may be grouped into two main types, according to their compositions and time of emplacement: 1. North-central, post- to anorogenic, porphyritic, coarse- to medium grained, predominantly a microcline-orthoclase granite, locally xenolithic with round inclusions of charnockite and gneiss, distinct flow structure and weak magnetism. These granites comprehend several sub-types for the less evolved sub-types granite, with sillimanite, cordierite occasionally and gneiss relics and the Caladão high-K granite, for the more evolved sub-type. Contacts between all granites are gradational, and between the less evolved granites and the surrounding country rocks contacts are either, transitional or sharp. The more evolved Caladão granite is not in contact with the country gneisses and migmatites containing along its border, only sparse xenoliths of charnockite. Both granite sub-types are crosscut by pegmatites and quartz veins. 2. Syn- to late-kinematic granites displaying varied textures and compositions from tonalite to granodiorite crosscut the São Tomé biotite schists (Araçuaí schist belt), Archean meta-ultrabasites and gneisses. Regionally, the granite zone is bounded by a charnockite belt to the east. While at the eastern Feldspar Belt zone the tonalite and granodiorite intrude the high-grade biotite schists with tourmaline, almandine, sillimanite and andalusite with intercalations of tourmalinite, in the western Mica Belt zone no granites occur. The biotite schist from the Mica Belt contains more quartzite layers than the Feldspar Belt and kyanite, spessartite and no sillimanite. Pegmatites of the North-central granites (Teófilo Otoni District) contain K feldspar, quartz in graphic texture and as isolated, large and well formed crystals, biotite, garnet and subordinate albite and muscovite. These pegmatites do not contain either cleavelandite or phosphate minerals. Apparently the pegmatites from the North-central granites were not affected by deformation, but only slight fracturing producing internal fissuring in the gems. Quartz crystals, hyaline and murion, were not affected, resulting in the big, up to 1 m-long clean and perfect crystals, indicating that quartz deposition occurred after deformation ceased. Aquamarine gems found in these pegmatites are of the best quality, markedly at Marambaia. Pegmatites crosscutting the less evolved granites contain topaz and beryl subordinately and are very poor in tourmaline. Chrysoberyl has been found mainly in the alluvial deposits. Aquamarine/topaz-bearing pegmatites intrude the Caladão granite where some of the famous and fine aquamarine has been extracted. Pegmatites from this

zone evolved as an orthoclase-quartz graphic material exsolving to large orthoclase-microcline crystals +quartz, subordinate albite and long biotite flakes, by increasing both, the Al/Si ratio and the Fe-content in the fluids. After most of the biotite has crystallized the F-content in the fluid dictated the following path: Under high F-content and increasing Al/Si ratios topaz would form, up to a dramatic decreasing in the F-content in the fluid, allowing the chrysoberyl crystallization. On the other hand, whether F-contents in the fluid are low, garnet will form with slight decrease in the Al/Si ratio. Persisting the Al/Si ratio decrease, and with the increasing Be-concentration, aquamarine would form, followed by brittle deformation forming micro-fissuring in topaz and aquamarine. Murion, hyaline, well formed quartz crystals, resulting from the ultimate Si-enrichment in the fluid, under no stress conditions, crystallized. Contrasting from the North-central zone, pegmatites related to the Galiléia District underwent ductile and brittle deformation. Quartz and murion gigantic crystals formed after deformation ended. The pegmatites may be grouped into a western, muscovite-rich zone and an eastern, feldspar-rich zone (Feldspar Belt). Green, blue, gem-type tourmaline, and phosphate- and lithium-bearing minerals are more concentrated in the western zone and roof pendants of biotite schist, such as the Galileia pegmatite field. Schorlite dominates the eastern zone, abundant in granite intrusions. Pegmatites from the Feldspar Belt occur as canoe-shaped, sub-vertical, concordant bodies in the biotite schist and as sub-horizontal sheets in the granites. Pegmatites, mostly zoned, from the Galiléia District can be subdivided into the Feldspar and Mica Belts and are enclosed in São Tomé biotite schist as concordant, steep dip bodies, and in granites as subhorizontal, tabular bodies. The Feldspar belt distributed at the Cons. Pena, Galiléia, area comprehend the biotite schists in the kyanite-sillimanite zone, invaded by tonalites, granites and granodiorites crosscut by pegmatites. A myriad of phosphate minerals characterizes this district. It could be noted that the phosphate minerals are arranged in a zonal framework forming a brazilianite-herderite zone to the north and a triphylite-lazulite zone to the south. Pegmatites within the biotite schist, fractured in a reticulate pattern, form isolate pockets during the waning stages of pegmatite crystallization, which propitiated the concentration of phosphate minerals of different compositions. Apatite, amblygonite, souzalite, scorzalite, gormanite, childrenite-eosforite, vivianite, wolfeite, dufrenite occur in both zones. The crystallization of the phosphate minerals started after most of the pegmatites formed, under reducing conditions, revealed by its association with sulfide minerals. Afterwards, crystallization of the phosphate minerals continued under oxidizing and more hydrated conditions. Tourmaline in this belt is schorlitic and beryl is mostly non-gem quality. The pegmatites from this zone evolved from a K feldspar-quartz in graphic texture towards a microcline-orthoclase, quartz, albite, biotite, cleavelandite, muscovite path, under increasing Al/Si ratio. The mica deposition corresponds to a critical stage in the fluid, whether to form tourmaline or garnet depending on its B-contents. After the deposition of tourmaline the Al/Si ratio in the fluid decreased allowing the beryl and the primary phosphate to crystallize. The still Si-rich fluids yielded the formation of murion and hyaline quartz, under no stress conditions. The metamorphic grade of schists and quartzites, is in the kyanite zone, lower than the gneisses of the Feldspar belt. Remnants of ultrabasic rocks, derived from a greenstone belt, some transformed either into anthophyllite or an assemblage of green epidote-actinolite, in beautiful crystals, are more common in this belt than in the Feldspar belt. Muscovite in the pegmatites are relatively abundant and feldspars, mostly weathered. Green tourmaline, morganite, spodumene, lepidolite, kunzite, beryl and herderite are the main minerals, and it is noteworthy the scarceness of phosphate minerals. Pegmatites are zoned with “ruby” mica, quartz and K feldspar and minor schorlite, biotite, garnet at the border zone. The Araçuaí-Cel. Murta district consists of pegmatites with Li-minerals, beryl, blue, green tourmalines, schorl, rubellite, blue topaz, aquamarine hosted in a non-deformed, xenolithic, leuco-granite and biotite schists. Pegmatites occur as concordant to discordant boudinaged bodies. K feldspar predominates over albite in 4:1 ratio. Biotite is largely predominant over muscovite. Limoeiro pegmatite forms a sub-horizontal sheet with K feldspar-quartz in graphic texture, muscovite in intergrowth with biotite, quartz core surrounded by cleavelandite coatings, large K feldspar, tourmaline and biotite. Late, steep fissuring in the pegmatite are filled by green-blue, gem-type tourmaline, morganite, herderite, apatite, blue and colorless topaz and fluorite. The Mingling Zone, described as a region where occurred the partial melting of the schist and the syn- to late-tectonic granites during the plutonic activity resulting in the North-Central granite, explaining the overlapping of mineralizations.

We envisage the strict correlation between the mineralizations and the metamorphic grade of the biotite schists. At the Feldspar belt, the metamorphic grade reaches the amphibolite facies, sillimanite zone, while at the Mica belt the metamorphic grade decreased to a kyanite-staurolite zone. That fact affects the thermal stability of the minerals in the pegmatites, allowing the regional distribution of muscovite, more abundant at the Mica belt, and the tourmalines compositions and color. In the Mica belt tourmalines contain less Fe and more gem-type varieties, differently from the Feldspar belt, where the Fe-rich, schorlite varieties dominate. The crystallization of the phosphate minerals evolved from reducing to oxidizing conditions.