

# Contributions to pegmatite exploration within granitic plutons in central and northern Portugal

B. Pereira, J. Azevedo, J. Oliveira, P.A. Dias  
Sinergeo, Ltd, Vila Verde, PT

C. Leal Gomes  
Departamento de Ciências da Terra, University of Minho, Braga, PT

J. Carvalho  
Geologia e Geotecnia Consultores, Ltd, Porto, PT

**Abstract.** Exploration programs for granitic pegmatites face the lack of detectable contrasts, either geophysical or geochemical, between pegmatites and their granitic host-rocks. The known productive sectors bearing pegmatites located inside granitic plutons, with economic interest for quartz and feldspar provide adequate field testing for alternative research, dealing with the peculiarities of lithological diversity and the arrangement of structural elements, around pegmatite swarms at suitable granite cupolas. The most efficient assessment for pegmatite positioning in tactical stages of exploration is the use of geological factors analyzed through raw or specifically treated remote imagery, enhancing the favorable lineaments and the most productive granite-host matrixes. The identification of targets using this approach led to a reasonable success tested by experimental drilling in some selected sites.

**Keywords.** Remote sensing, pegmatite, quartz, feldspar, granite, Portugal.

## 1 Introduction

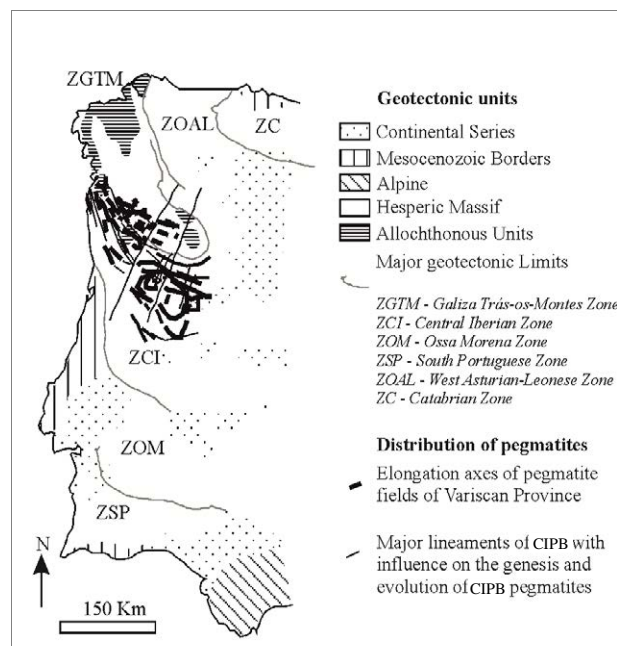
Irregularly shaped pegmatites are the main source of industrial quartz and feldspar in Central and Northern Portugal. They may occur as clusters of small sized bodies individually reaching up to 150000 tons of industrial quartz and feldspar. However, no specific exploration methodology has been applied for locating such pegmatitic deposits.

## 2 Orogenic constraints for pegmatite emplacement

In Central and Northern Portugal the pegmatite distribution is related to the emplacement of Variscan granites and follows its main structural trends, as shown in Figure 1.

Their spatial location and structural trend led to the definition of the Central Iberian Pegmatite Belt (CIPB) (Leal Gomes and Nunes, 2003)

This belt was conceived on the basis of a regional unit – the pegmatite field – allowing the structural discrimination of the pegmatitic bodies having distinguishable shape, size, internal structure, paragenesis and granite affiliation (Leal Gomes and Nunes, 2003).



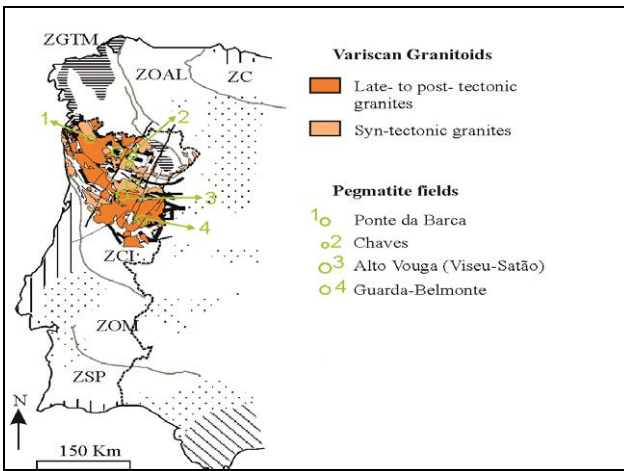
**Figure 1** – Location and trends of pegmatite fields in the Central Iberian Pegmatite Belt according to Leal Gomes and Nunes (2003).

## 3 Regional structure of pegmatite fields in North and Central Portugal

Prior structural analysis of inner-granite swarms of irregular (non-tabular) pegmatite bodies in CIPB – Variscan Province (fig. 2) – yielded the assumption of four major patterns of 3D organization at the top of the assumed, parental magma chambers (Leal Gomes, 1995, 2010):

- 1 – pegmatite swarms are genetically and spatially related to mingling corridors expressed as aligned outcrops of xenolith clusters, granular enclaves and roof-pendants;
- 2 – individual volumes with variable modal compositions concentrate in the apical sectors of plutons; these volumes evolve by fractionation
- 3 – occasionally, the magma flowing under sub-newtonian conditions allows the formation of irregular pods of pegmatite drawing curvilinear trends that can be field-mapped; convoluted-flow lineaments and helicoidal shapes have been recorded;

4 – metric to decametric pegmatitic bodies occur in the vicinity of the host-granite's contacts; the pegmatites are aligned with the feldspar phenocryst and their trend is related to the magma flow.



**Figure 2.** Location of the studied pegmatite fields according to the geographical distribution of syn and late to post-tectonic granites (divisions for Iberian Massif as in fig.1).

The upper-mentioned patterns of distribution, supported the present investigation concerning the adequacy and liability of existent exploration methods for the detection of sub-surface, buried or hidden, pegmatite pods. The lack of detectable indirect contrasts due to weak

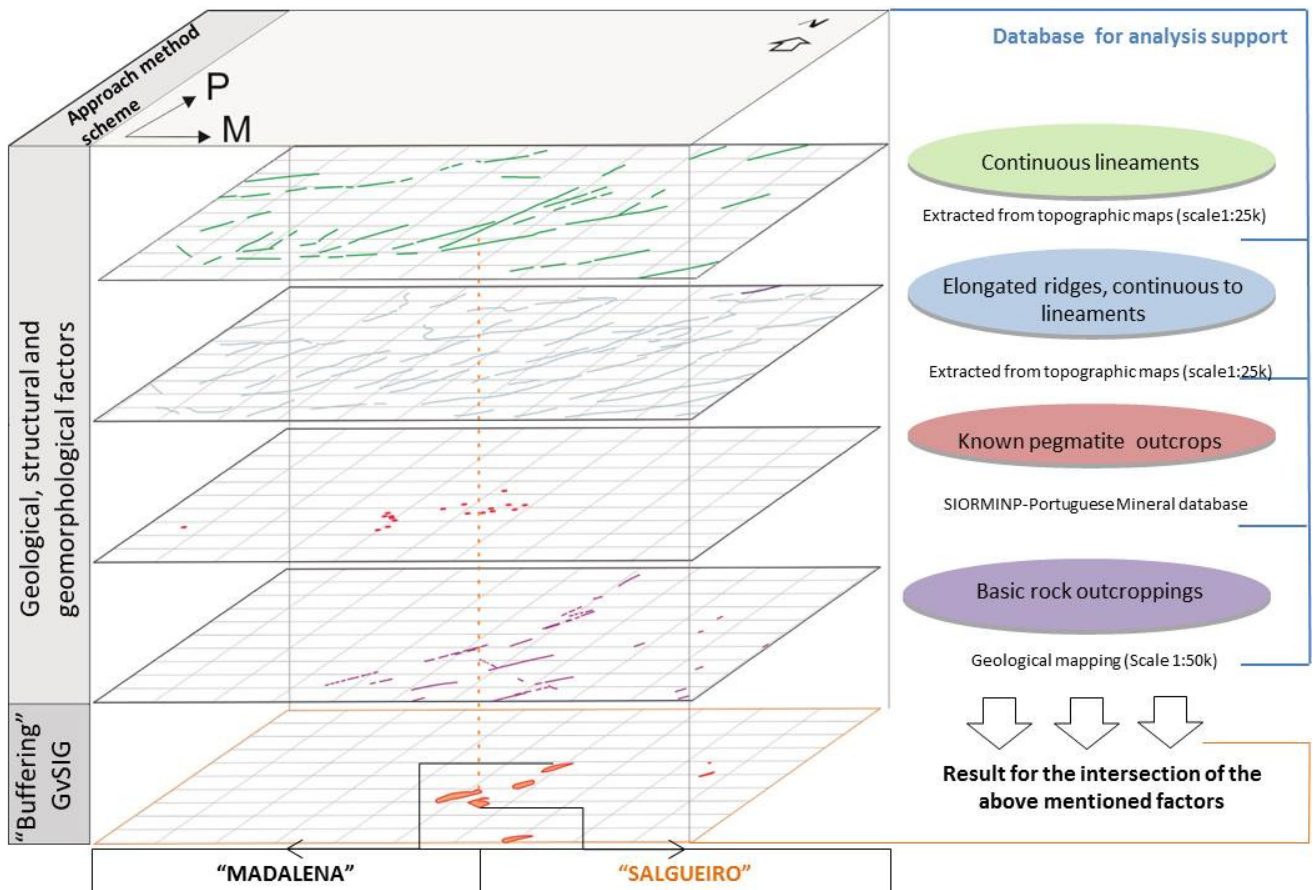
geophysical and geochemical boundaries between pegmatite, granitic lithologies and soils as well as the dimensions of the expected and observed pegmatites, strongly suggested the choice of an alternative exploration method.

In this study, the applied approach combines remote sensing and 3D modeling of the pegmatite distribution. Remote assessment and analysis included straight or specifically treated imagery, establishing the enhancement of favorable lineaments and remote rock matrix adjustments, through Maximum Likelihood Estimation (MLE), searching for the combining factors that make the presence of pegmatite bodies most probable (Pereira et al, 2011).

#### 4 Case study

In the example of Alto Vouga pegmatite field (fig. 3), overlapping of geological, geomorphological and structural factors, allowed the identification of “Salgueiro” as the area of potential economic interesting fig. 3.

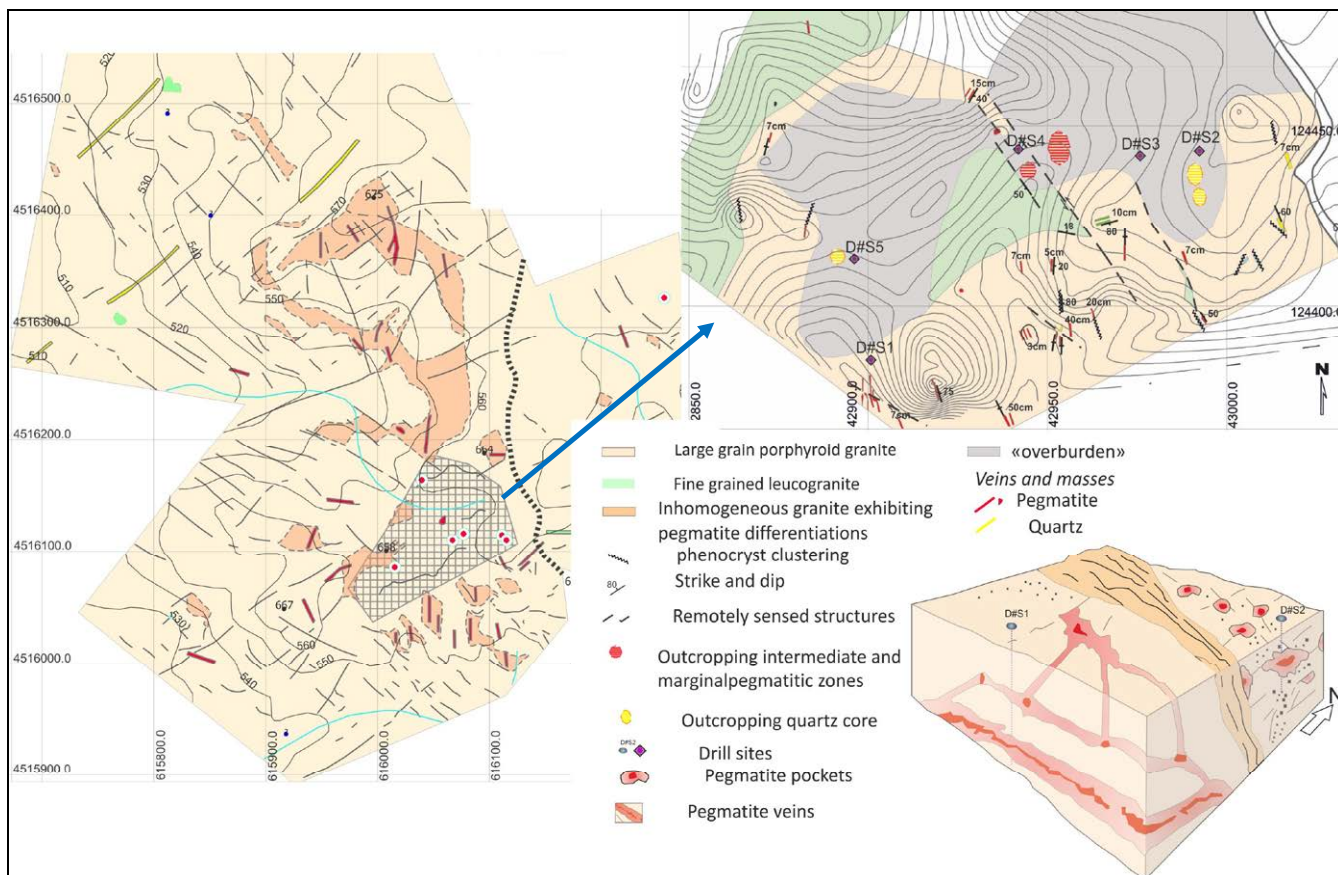
As shown, the first step of the approach consisted on the generation of a geometrical intersection, inside a GIS environment, for the expression of the chosen criteria. The overlapped areas (shown in red in the same fig. 3) were selected and targeted for subsequent remote sensing and fieldwork



**Figure 3.** Example of map layering, applied to different selection factors within the Alto Vouga pegmatite field.

Afterwards, a conjunction of SPOT and Google Earth PRO imagery with detailed geological mapping, allowed

the construction of the geological map shown in fig. 4.



**Figure 4.** Detailed mapping and 3D conceptual model for the distribution of pegmatites in "Salgueiro" site, within the Alto Vouga pegmatite field.

A conceptual, 3D model, was generated from the structural and lithological data (fig.4), and supported the implementation of a drilling program – drill holes D#S1 to D#S5.

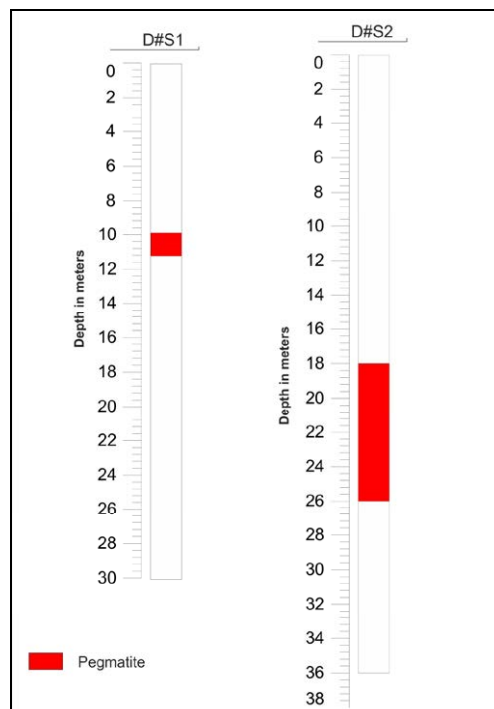
The most encouraging results of this preliminary program are shown in fig. 5. The drillhole intersections of some non-outcropping, medium sized, pegmatite pods, suggest the development of a subsequent drilling program. Furthermore, the preliminary results support the adequacy of the chosen 3D model.

### 5 Conclusions

When the signature of an individual pegmatite is considered, scale inadequacy is the major obstacle concerning the resolution-detection level of selected satellite imagery.

But, some encouraging results were obtained at the identification of bigger areas with potential for holding clusters of economic pegmatite bodies.

The results of the drilling campaign revealed that the used combination of methods is useful as a medium scale and tactical tool. In favorable structural and image-solvable situations the proposed method allowed the direct drilling intersections obtained in the case of drill holes S1 e S2 (fig. 5).



**Figure 5.** Pegmatite intersections in D#S1 and D#S2 sites – site location shown in fig. 4.

## Acknowledgements

This contribution is attributed to PROSPEG project ([www.prospeg.org](http://www.prospeg.org), ref. 11480), co-supported by the “ON.2 – O Novo Norte” and QREN through the European Regional Development Fund (ERDF)

## References

- Leal Gomes, C. (1995) - Anatomia e classificação de pegmatitos cerâmicos intra-graníticos do Norte de Portugal. Memórias n°4, publ. mus. lab. mineral geol., Univ. Porto, pp. 725-729.
- Leal Gomes, C. (2010) - Distribuição espacial dos recursos de materiais cerâmicos pegmatíticos no noroeste de Portugal – matriz orogénica e metalogénese relacionada - “Ciências Geológicas – Ensino e Investigação e Sua História” - Volume II - Capítulo I - Geologia e Recursos Geológicos, pp. 25 – 36.
- Leal Gomes C, Nunes J E L (2003) Análise paragenética e classificação dos pegmatitos graníticos da Cintura Hercínica Centro-Ibérica. A Geologia de Engenharia e os Recursos Geológicos, Coimbra – Imprensa da Universidade II:85-109.
- Pereira, B, Oliveira, J, Azevedo, J, Dias, P, Leal Gomes, C, Carvalho, J, Marques, A (2011) – PROSPEG Projecto de Prospecção, Análise distanciada e Detecção Remota de Pegmatitos, “Valorização de pegmatitos litiníferos”, Eds Luis M P Martins, Daniel P S de Oliveira, Rita Silva, Helena M C Viegas, Roberto C Vilas Boas, Lisboa, Portugal, DGEG/LNEG/ADI/CYTED, pp.71–73.