# Remote sensing and ground techniques, applied to the characterization of a new viticultural region at Pinto Bandeira, Brazil

# Télédétection et techniques au sol appliquées à la caractérisation d´une nouvelle région viticole à Pinto Bandeira, Brésil

André Luis Silva COUTINHO[1], Jorge Ricardo DUCATI[1]*, Rosemary HOFF[2][1]Centro Estadual de Pesquisas em Sensoriamento Remoto e Meteorologia
Universidade Federal do Rio Grande do Sul Av. Bento Gonçalves 9500 – CEP 91501-970 Porto Alegre, Brazil
[2]Centro Nacional de Pesquisas em Uva e Vinho
Empresa Brasileira de Pesquisa Agropecuária – EMBRAPA Bento Gonçalves, Brasil

***Corresponding author**:ducati@if.ufrgs.br

## Abstract

The region of viticultural production near Pinto Bandeira, Brazil, is being studied to define typical characteristics of wines locally produced. Vineyards above altitudes of 500m qualify as "Mountain Wines", a geographical denomination. Rocks, soils, and wines are analyzed. Several techniques are used: remote sensing, radiometry, and chemical analysis. Results indicate that elements (Fe, Cu, Mg, Al, and others) from rocks and soils are not detected in wines. However, minerals present in rocks and soils (montmorillonite, mordenite, illite) can be traced in wines, indicating a transmission of soils descriptors to wines. Geological maps of the region were generated from images of SPOT, Landsat and ASTER satellites.

**Keywords**: geographical indication; remote sensing; radiometry; soils

## Introduction

The region known as "Serra Gaúcha" in Rio Grande do Sul State, south Brazil, has a tradition in wine production, thanks to the fact that Italians settlers arrived there, starting in 1875. Production of quality wines from vinifera grapes was intensified around 1960, and in 1992 the first geographical denomination was granted to the then called "Vale dos Vinhedos". Other regions are seeking similar characterizations, including a zone around Pinto Bandeira village. As the main typical feature, producers there have their vineyards above altitudes of 500m, calling their production "Mountain Wines". However, one of the requisites to a geographical denomination is a description of typical features, including the soils where vines grow, and which influence wines get from soil and bedrock, as a way to define a "terroir", in the sense defined by van Leeuwen and Seguin (2006). This work reports studies made to support this effort, using techniques based on remote sensing, radiometry, and chemical analysis.

## Material and Methods

Images from several satellites were used. At initial phases, images from SPOT and Landsat-TM helped to define the region; afterwards, data from the ASTER imager (Terra satellite; Abrams et al. (2002)) were used to study soil use and cover, these images being suited to monitor vineyards, as recently reported (Silva and Ducati 2006). This sensor has devices for collecting information in three separate subsystems: at visible and near infrared wavelengths (VNIR, bands 1 to 3), it is possible to map the use and cover of land, locate areas of anthropic action, and identify vegetation and geological structures. At short wave infrared (SWIR, bands 4 to 9), it is possible to separate soil types, and see their spectral behavior. The thermal bands (TIR, 10 to 14) are useful to separate acid and intermediary rocks from basic ones, and detect silica contents. An image of October 2002 was used (Fig. 1) to select vineyards, from criteria of topography, soils, and even distribution throughout the area.

At ground level, field trips were made to six properties, where 10 vineyards of grape varieties Cabernet Sauvignon and Merlot were selected. Rock and soil samples were collected at all parcels. Grape samples were kindly provided by owners, and microvinification was made at EMBRAPA laboratories at Bento Gonçalves. Rocks were grinded to fine dust, and radiometric measurements were performed with equipments from CPRM/Brazilian Geological Survey at Porto Alegre (POSAM device), and from INPE/Brazilian Institute of Space Research at São José dos Campos (GER device). Chemical elemental analyses were made at EMBRAPA.
The lithological delimitation was made from a SPOT image, composition RGB123 with 10m resolution. Morpho-structures were made from band 8 of a Landsat 7/TM, supported by an altimetric model from an ASTER image, from which the 500 limit for altitude was defined.

## Results

The geological map constructed from orbital images is presented in fig. 2. The local geological facies (Gramado, Caxias) are shown.
Figures 3 and 4 show examples of spectra of rocks and of the dried extract of wine, both from the Valmarino Winery. Spectral lines of montmorillonite, mordenite, and illite, detected on rocks (Fig. 3), are identified in wine (Fig. 4), in 1420, 1900, and 2200 nm.
Radiometric measurements lead to the identification of minerals as montmorillonite, from the group of sericite and zeolite, typical of vulcanic rocks of the Serra Geral formation. Examples of spectral signatures are given in Fig. 5. Differentiation of basic rocks from acid and intermediary rocks was attained from ASTER SWIR bands. Basic rocks from Facies Gramado are reflective at band 4, and have absorption at band 7. Acid and intermediary rocks from Facies Caxias reflect at band 5 and absorb at band 6.

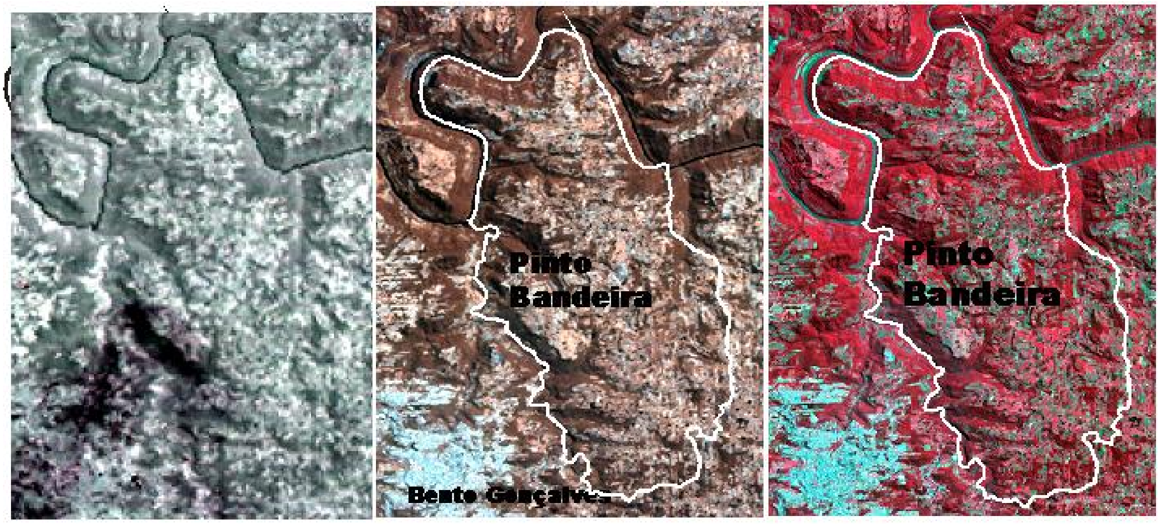


**Figure 1 Set of three ASTER bands compositions of region of Pinto Bandeira, Brazil. Left, thermal wavelengths, composition of bands 12-14-13 of TIR; center, near infrared bands, composition 4-6-8 of SWIR; right, visible and near infrared, composition 3-2-1 of VNIR. Image of October 2002.**

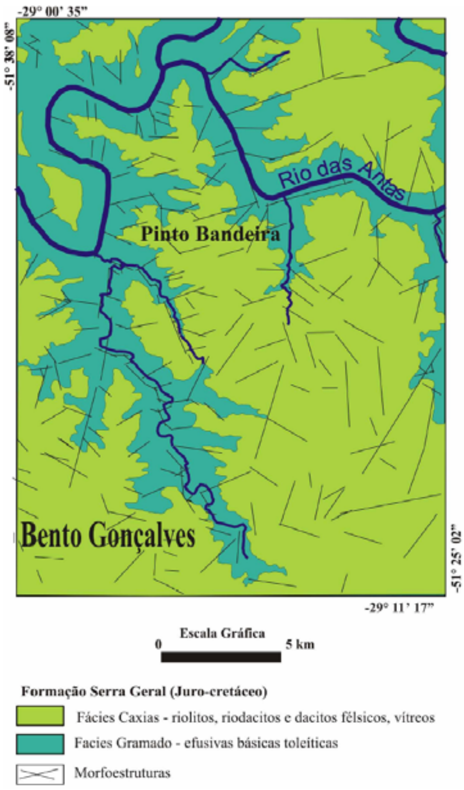


**Figure 2 Geological map obtained by interpretation of orbital images.**

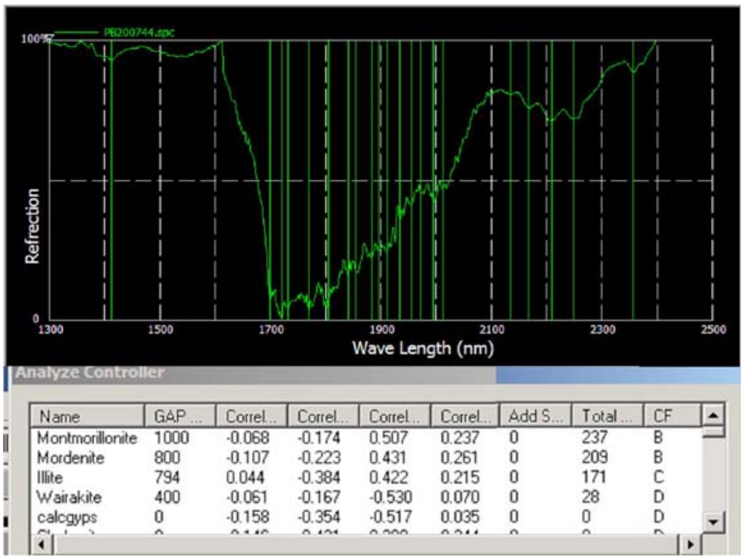


**Figure 3 Example of spectrum issued from radiometry of rock samples ollected from a Merlot vineyard at Valmarino winery. Minerals wth more probable identifications (grades B and C) are shown.**

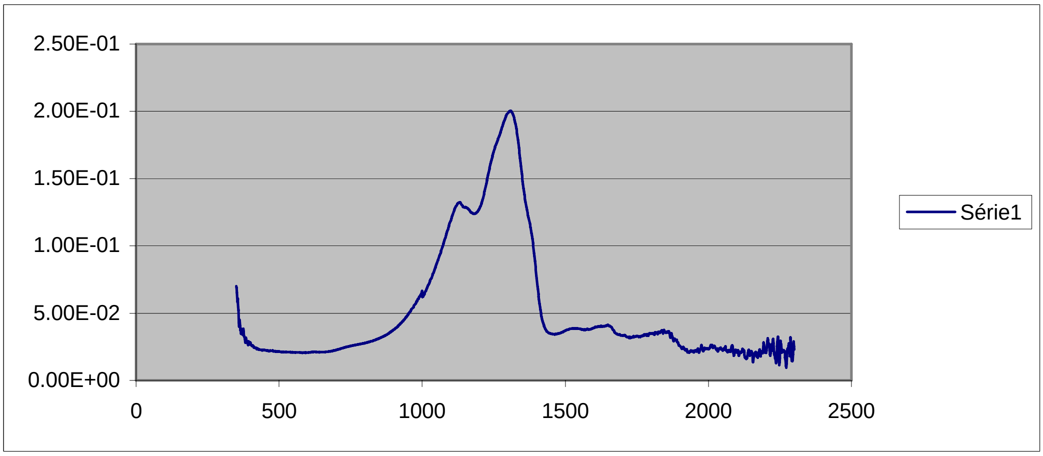


**Figure 4 Espectrum produced by radiometry of dried extract of Merlot wine, produced from Valmarino vineyard.**

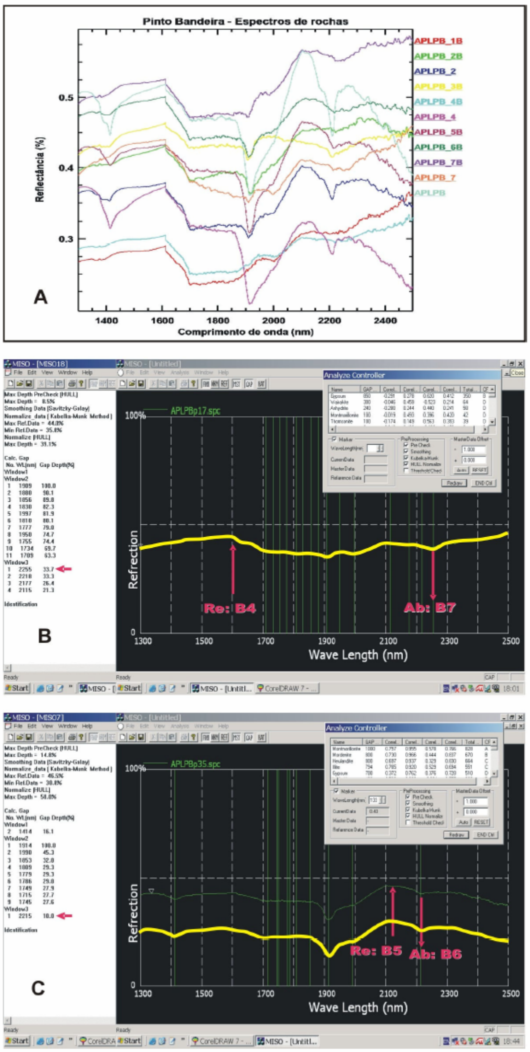


**Figure 5 Spectral signatures obtained from POSAM spectroradiometer. A) set of measured spectra; B) spectrum of basic rock, reflecting at band 4 and absorbing at band 7; C) spectrum of acid to intermediary rock, reflecting at band 5 and absorbing at band 6. Bands are those of ASTER SWIR subsystem.**

Chemical analyses of wines (dry extract) produced information on abundances of elements K, Na, Ca, Mg, Cu, Fe, Zn, Rb, Li, and P. No clear correlations were found with results for minerals, from radiometry of rocks or soil.

## Conclusions

It seems that minerals from rocks and soils of vineyards can be detected in wines produced from same parcels. However, elements found in wines are not traced down to the ground, at least at this initial stage of analysis.

The digital processing of images from SPOT, ETM+ LANDSAT 7 and ASTER, applied to the study of spectral features of rocks and soils of Pinto Bandeira, was a positive contribution to the viticultural zoning of that region. It was possible to differentiate litho types and to construct a detailed map (Schobbenhaus, 2004), important steps towards the geographical denomination of Mountain Wines/Pinto Bandeira for fine wines (Hoff et al, 2006).

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