



# VIII SIMPÓSIO DE VULCANISMO E AMBIENTES ASSOCIADOS

VIII Symposium on volcanism and related settings

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## VOLCANIC WINES OF ALTITUDE

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Geology impacts our lives in the most unusual ways. And who knew that it could get involved with Bacchus, the Roman God of wine. Around the world vines are planted in areas formed by the most different types of rocks (igneous, metamorphic and sedimentary) and non-consolidated deposits (sedimentary and volcanic). The bedrock of several wine regions, such as Napa Valley (USA), Rapel Valley (Chile), São Joaquim (Brazil), Pico Island (Portugal), Mount Etna (Italy) and Tokaj (Hungary), is composed of volcanic rocks. The wines produced in these places are called volcanic wines. There are also a lot of wine regions in areas of altitude and the wines produced in these regions are called wines of altitude. The highest vineyard in the world belongs to the Bodega Colomé winery that is located in the region of Salta (Argentina) at an altitude of 3,100 meters. But what are volcanic wines of altitude? Well, those are the wines produced with European grape varieties (*Vitis vinifera*) grown in soils formed by the weathering of volcanic rocks of the Serra Geral Group (Paraná-Etendeka Magmatic Province) in vineyards with altitudes above 900 meters in the State of Santa Catarina (Brazil). The Paraná-Etendeka Magmatic Province was formed around 134 Ma ago (Lower Cretaceous) by a large magmatic event, that preceded the breakup of the supercontinent Gondwana and the opening of the South Atlantic Ocean, in an area that now is found two counterparts: South America and Africa. It is considered one of the largest igneous provinces in the world with an estimated volume of at least 1,700,000 km<sup>3</sup>. In São Joaquim region the geology of the vineyards is composed of two volcanic units (felsic and mafic) of the Serra Geral Group. The felsic volcanic unit (68.07 - 69.17 w.t.% SiO<sub>2</sub>) is formed by low-titanium dacites (0.86 - 0.91 w.t.% TiO<sub>2</sub>) of Palmas magma-type, which have a silica-rich glassy matrix with predominance of plagioclase and pyroxene. The mafic volcanic unit (49.83 - 57.61 w.t.% SiO<sub>2</sub>) is formed by trachybasalts and basaltic trachyandesites (49.83 - 52.14 w.t.% SiO<sub>2</sub>) with high-titanium (3.61 - 4.10 w.t.% TiO<sub>2</sub>) of Urubici magma-type and by basalts, basaltic andesites and andesites (50.31 - 57.61 w.t.% SiO<sub>2</sub>) with low-titanium (1.27 - 1.59 w.t.% TiO<sub>2</sub>) of Gramado magma-type, which have an intergranular texture with predominance of plagioclase and pyroxene. The main grape varieties grown in São Joaquim region are Cabernet Sauvignon, Merlot, Sauvignon Blanc, Sangiovese, Pinot Noir, Chardonnay, Montepulciano, Cabernet Franc, Vermentino and Touriga Nacional. The volcanic wines of altitude produced with those grapes have the following characteristics: the white wines have a light yellow color with greenish reflections and aromas of citrus and tropical fruits with vegetable notes, and the red wines have a dark ruby color with violet tones and aromas with fruity and vegetable notes. Another remarkable characteristic of the wines of São Joaquim is their acidity which allows them to age longer in the bottle, this is due to its *terroir* (meteorological, physiographic, pedological, geological and viticultural factors) that influences the vitiviniculture of a region. The impact of the geological factor in the vitiviniculture of São Joaquim can be observed in the geological rocks and settings and further fault control uplift processes that are responsible for the current location of the region (latitude and altitude), which influences the temperature (decrease of 0.5 °C for each 100 meters in altitude) and therefore the grape varieties that are most suitable for its cultivation. São Joaquim is considered to be the highest and the coldest vitivinicultural region in Brazil with vineyards between 1,096 and 1,431 meters of altitude and average temperatures varying from 13.8 to 14.7 °C. The volcanic wines of altitude are an amazing example of how geology is present in our lives in the most unusual ways and the importance of an holistic approach in geosciences to the understanding of nature.

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Keywords: Viticulture; Serra Geral Group; Santa Catarina.



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## STRONTIUM ISOTOPES ( $\text{Sr}^{87}/\text{Sr}^{86}$ ) AS AN INDICATOR OF PROVENANCE FOR THE VOLCANIC WINES FROM SÃO JOAQUIM, SERRA CATARINENSE REGION

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Strontium isotope ratios ( $\text{Sr}^{87}/\text{Sr}^{86}$ ) can be used for forensic applications to agricultural provenance, human and animal migration, and criminal investigations because Sr is readily absorbed by biological materials (plants, animals and humans) and incorporated in their manufactured products. The Sr isotopes of these flora, fauna and humans preserves the variability of the geological materials (rocks, minerals, soils and water) in which agricultural produce grew or animals and humans lived. Studies around the world, particularly in Canada, Italy and Brazil, have confirmed that the  $\text{Sr}^{87}/\text{Sr}^{86}$  ratio can be used to indicate the geographic origin of wines. We present the first  $\text{Sr}^{87}/\text{Sr}^{86}$  isotope study for wines derived from the Santa Catarina region of south Brazil with the goal of characterizing wines associated with the recently created *Indicação de Procedência Vinhos de Altitude de Santa Catarina*. The municipality of São Joaquim is the main vitivicultural region in the Serra Catarinense and produces wines from European grape varieties (*Vitis vinifera*) grown in soils formed by the weathering of volcanic rocks of the Serra Geral Group (Paraná-Etendeka Magmatic Province). The goal of this study is to evaluate the forensic application of strontium isotopes ratio ( $\text{Sr}^{87}/\text{Sr}^{86}$ ) as an indicator of provenance for the wines from São Joaquim. The strontium isotope ratios ( $\text{Sr}^{87}/\text{Sr}^{86}$ ) of rocks, soils (bulk and labile fractions), grape vines (leaves and grapes) and wines (Sauvignon Blanc and Cabernet Sauvignon) from four wineries from São Joaquim were analyzed at the Geotop research centre (Université du Québec à Montréal) using a thermal ionization mass spectrometer (TIMS). The geology of the four vineyards is characterized by the presence of three different types of volcanic rocks: (1) high-titanium ( $\approx 4$  w.t.%  $\text{TiO}_2$ ) basaltic trachy-andesite of the Urubici magma-type, (2) low-titanium ( $< 2$  w.t.%  $\text{TiO}_2$ ) basaltic andesite of the Gramado magma-type, and (3) two vineyards with dacites with low-titanium ( $< 1$  w.t.%  $\text{TiO}_2$ ) of the Palmas magma-type. The  $\text{Sr}^{87}/\text{Sr}^{86}$  isotope ratios obtained for the rocks were consistent with values observed in the literature ranging from 0.7054 for the basaltic rocks to 0.7248 for the dacites. The analyses yielded a strong correlation between the  $\text{Sr}^{87}/\text{Sr}^{86}$  ratios of the leaves and berries, however, there was no correlation between soil (bulk or labile fractions) and wine samples. This indicates that the Sr concentrations of the leaves and berries were not altered by external factors where as the Sr concentrations in the soils and wines may be modified by agricultural practices in the vineyard such as liming (addition of calcium) and by enological practices in the winery such as clarification (addition of bentonite). In order to evaluate this hypothesis, new analyses of the soil samples without liming and of the wine samples without clarification are required.

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Keywords: Strontium Isotopes; Viticulture; Serra Geral Group.