SRTM-based morphometric analysis of the Poços de Caldas Alkaline Massif, southeastern Brazil

GEOCIÊNCIAS USP

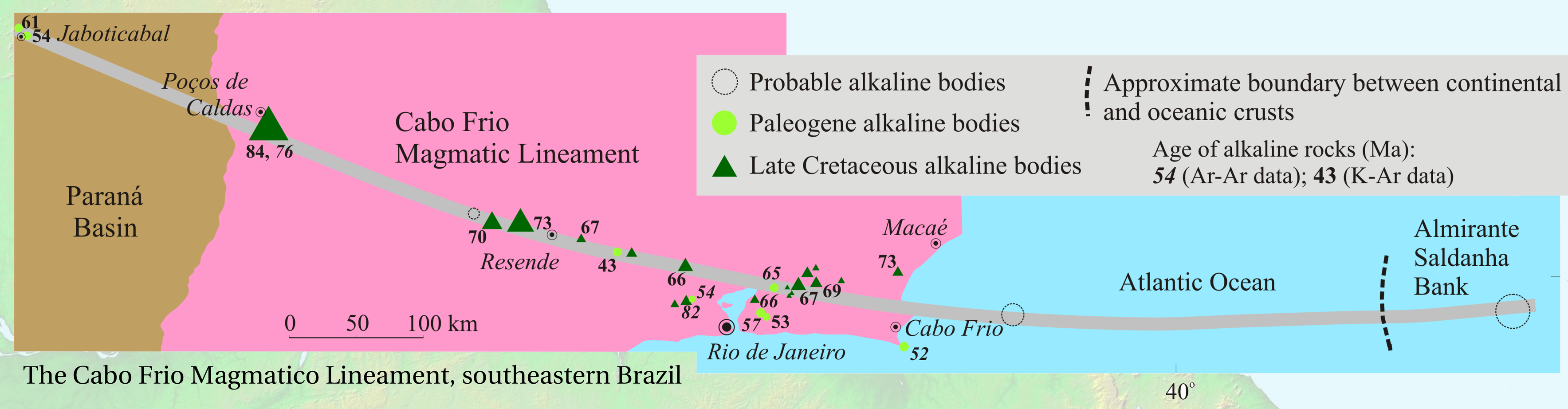
FAPESP

Carlos Henrique Grohmann [1,2]; **Claudio Riccomini** [1]; **Fernando Machado Alves** [1]

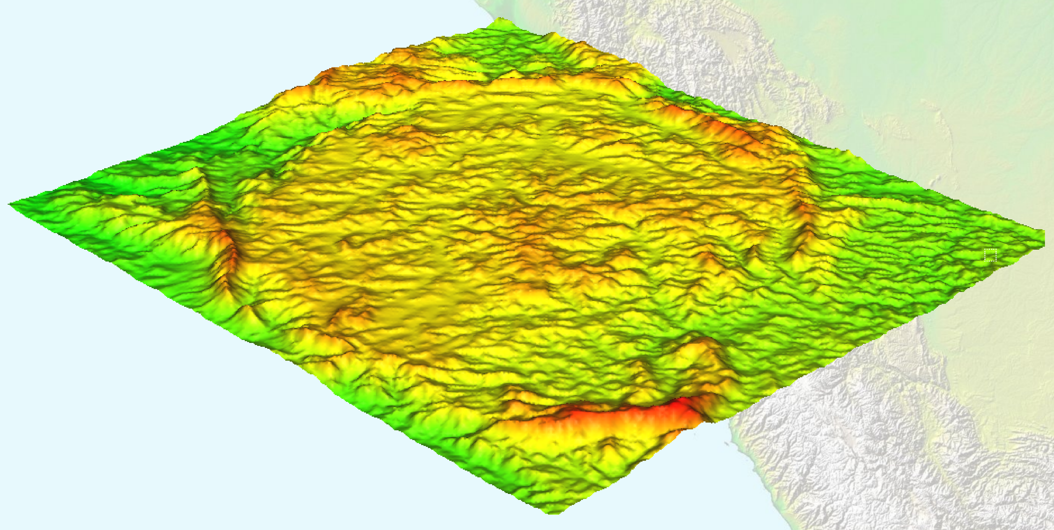
1 – Institute of Geosciences, University of São Paulo, Brazil

2 – email: *guano@usp.br*; FAPESP doctor's degree fellowship #04/06260-5 and grant #01/10714-3

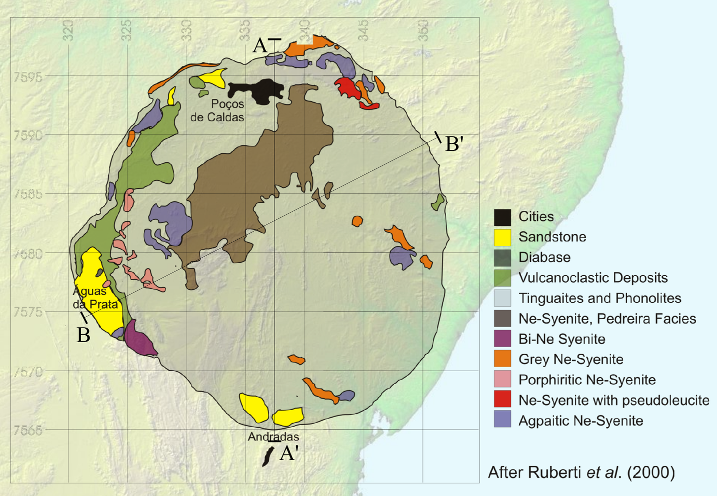
The Poços de Caldas Alkaline Massif (PCAM) is a Late Cretaceous collapsed volcanic caldera affected by syenite intrusions and alkaline dikes, located in the central-western portion of the Cabo Frio Magmatic Lineament (CFML), a 1000km-long alignment of Late Cretaceous and Paleogene alkaline bodies in southeastern Brazil.



The Cabo Frio Magmatico Lineament, southeastern Brazil

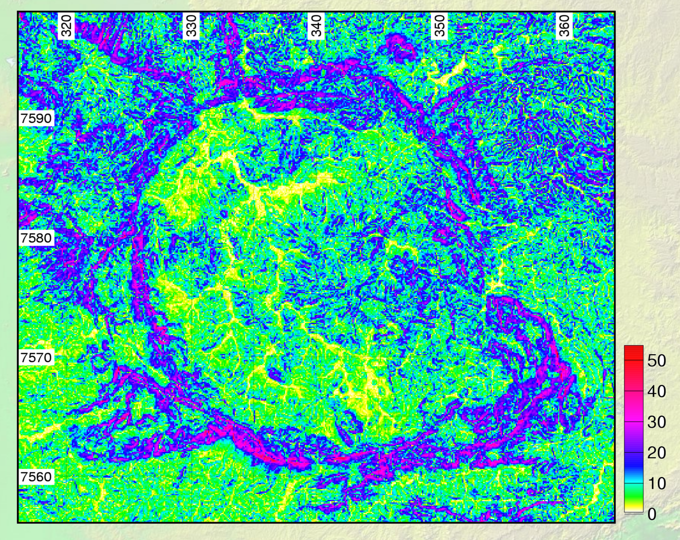

3D-perspective of Poços de Caldas Alkaline Massif, view from southeast to northwest

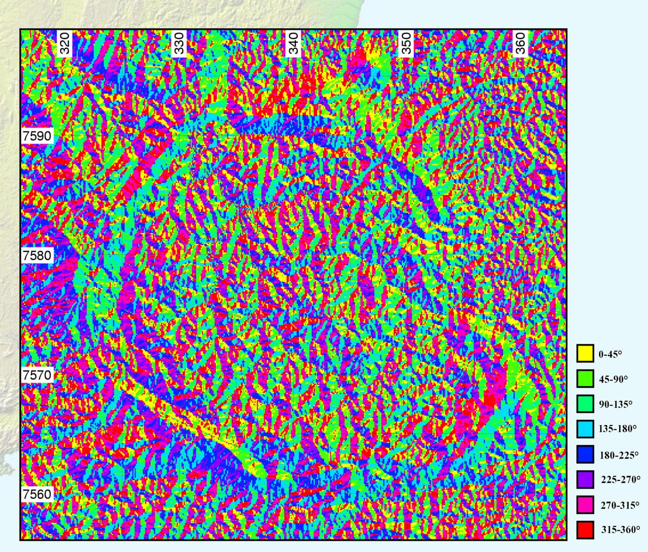
PCAM's main morphology is a semi-circular plateau with average altitude of 1300m, rising up to 400m above surrounding flatlands. The plateau is a remnant of the South American Planation Surface and resulted from differential erosion of basement rocks and volcanic ring dikes around the massif at the Late Cretaceous-Paleogene transition. Landforms within the massif have close relationship with Pleistocenic and Holocenic tectonic structures. The contrast between tectonic and lithologic influence on geomorphology favours morphotectonic analysis.

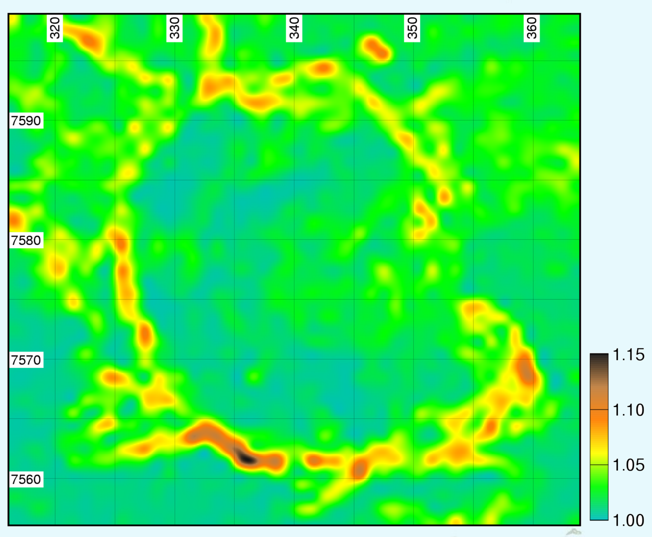


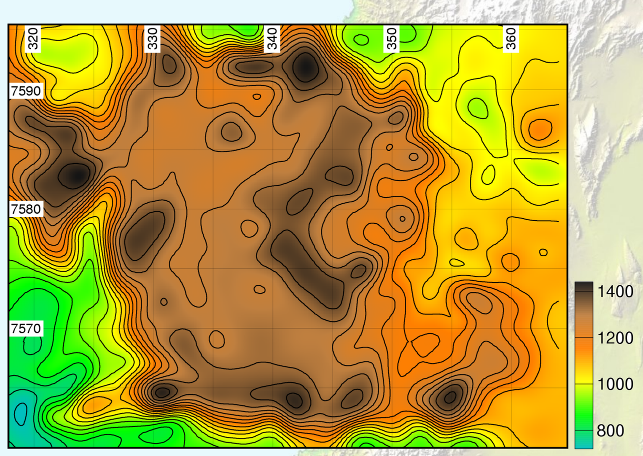
Simplified geological map

Using SRTM 90m elevation data, morphometric analysis of PCAM was carried out with free software GRASS-GIS, as proposed by Grohmann (2004). DEM resolution was resampled to 50m in order to work at a scale of 1:50.000. The following parameters were evaluated: slope, aspect, surface roughness and isobase surface.

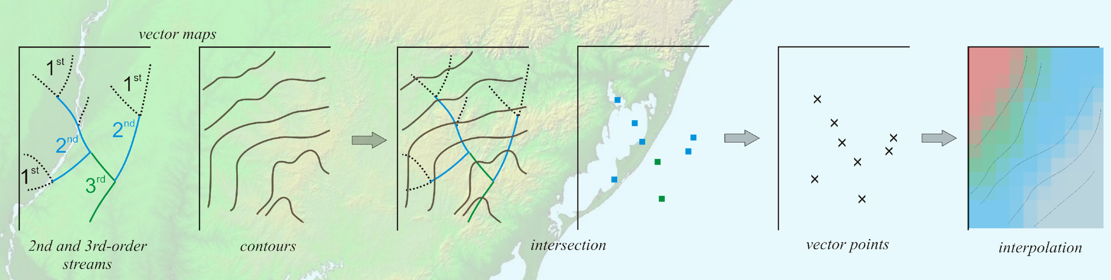

Slope map


Aspect map

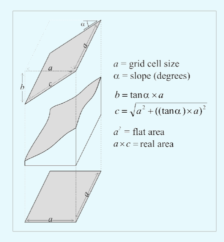

Surface roughness map, for cell with 1x1 km


Isobase map

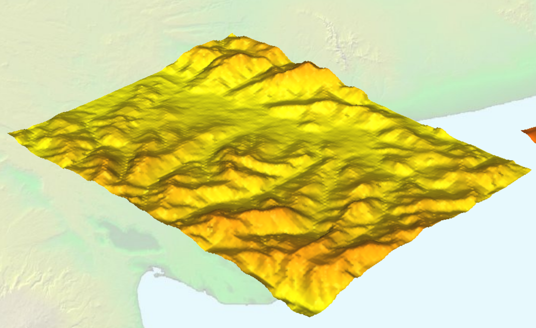
Surface roughness was calculated as the ratio between real and planar area for cells of 1x1km. Isobase surfaces are interpolated from the intersections of 2nd and 3rd-order stream channels with contours.

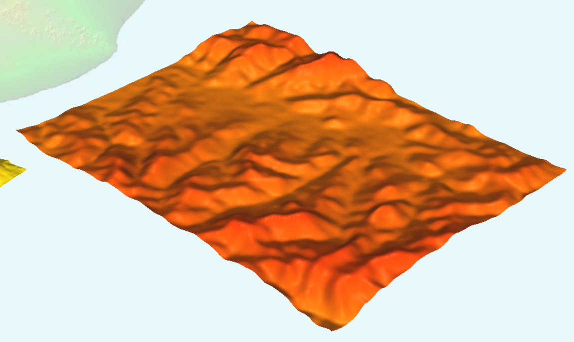


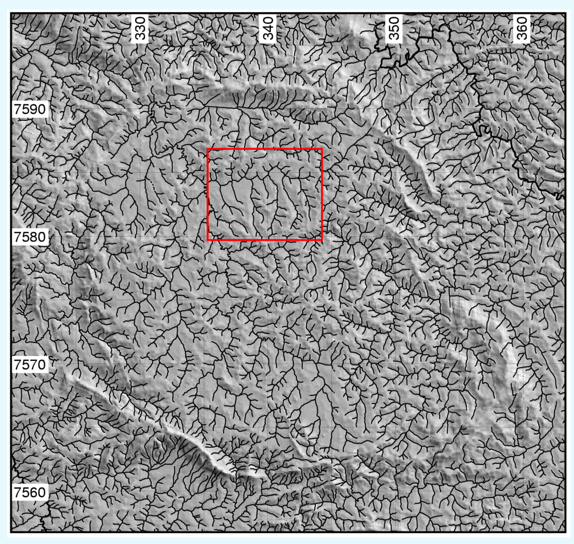
Procedure to obtain isobase surface map

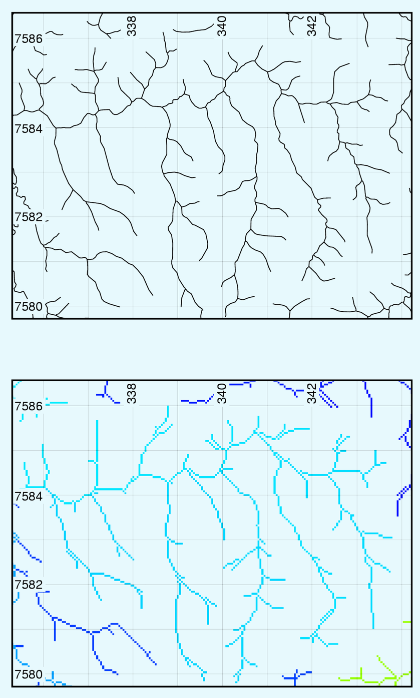

Geometric relations between regular grid and slope

To derive the drainage, the DEM was first smoothed with a 7x7-cell neighborhood operator (`r.param.scale` command, Wood 1996), and flow direction was obtained with the A^T least-cost search algorithm (`r.watershed` command, Ehlschlaeger 1989); raster streams were then converted to vectors and manually classified (`v.digit`).

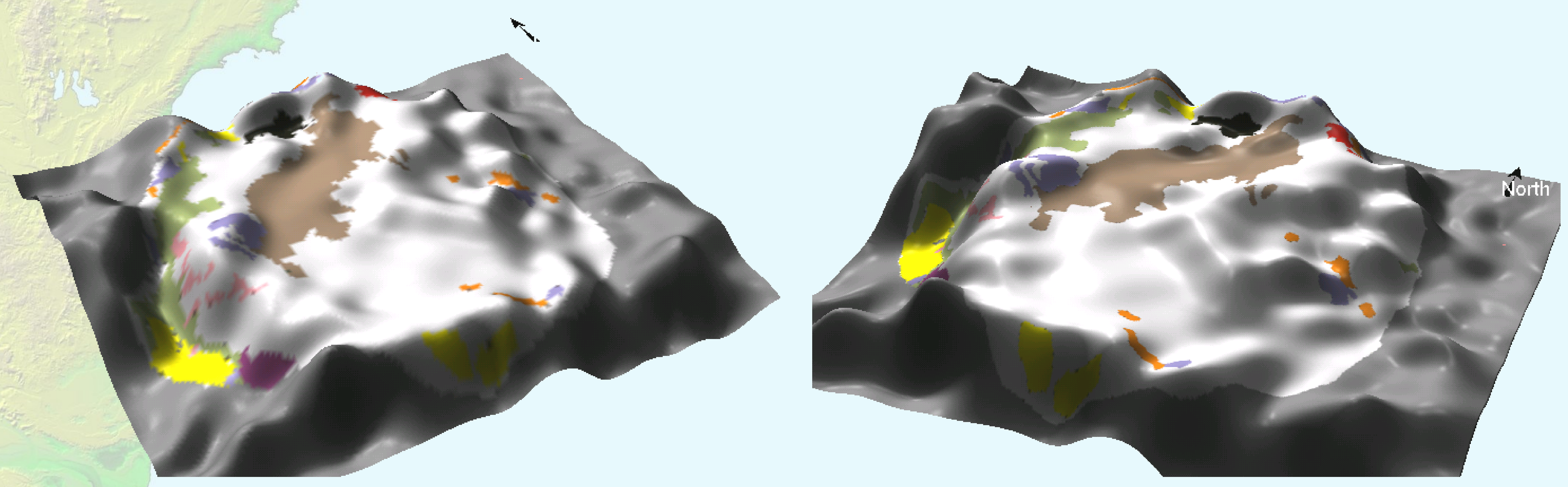

Original DEM, 50m spatial resolution


DEM after 7x7-cell smooth

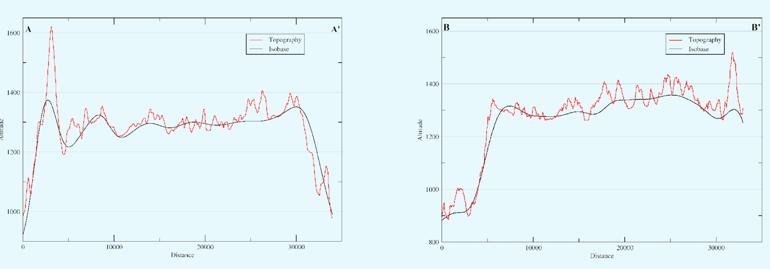

DEM-derived drainages over shaded relief image


Upper: Drainages from 1:50.000 topographic map
Lower: Drainages derived from SRTM DEM

3D-visualization of geology drapped over isobase surface helps to understand wheras isobase anomalies are due to lithological changes or related with recent tectonic activity.



3D-views of geology drapped over isobase surface


Morphological profiles of Topography and Isobase. (location of profiles on geological map)

There is a good correlation between DEM-derived drainage and topographic maps showing that even at a relatively coarse resolution, SRTM can be used for semi-detailed geomorphological analysis. Availability of data assures that analysis can be carried out in a fast and inexpensive way.

References

Ehlschlaeger, C.R., 1989. Using the A^T Search Algorithm to Develop Hydrologic Models from Digital Elevation Data. *Proceedings of International Geographic Information Systems (IGIS) Symposium '89*, Baltimore, pp:275-281.

Grohmann, C.H., 2004. Morphometric analysis in Geographic Information Systems: applications of free software GRASS and R. *Computers and Geosciences*, 30:1055-1067.

Wood, J., 1996. Scale-based characterisation of Digital Elevation Models. In: Parker D. (ed.) *Innovations in GIS 3, Ch. 13, London:* Taylor and Francis.