Geophysical Research Abstracts
Vol. 21, EGU2019-5870, 2019
EGU General Assembly 2019

Temperature, composition, and strength variability of the Australian lithosphere

Magdala Tesauro (1,2), Mikhail Kaban (3,4), Alexey Petrunin (3,4), and Alan Aitken (5)

(1) Trieste University, Trieste, Italy (mtesauro@units.it), (2) Utrecht University, Utrecht, Netherlands (m.tesauro@uu.nl), (3) GeoForschungsZentrum Potsdam (GFZ) (kaban@gfz-potsdam.de), (4) Schmidt Institute of Physics of the Earth, Moscow, Russia, (5) University of Western Australia

The Australian plate has a long and complex tectonic history. The continental crust was accreted in three major episodes from the Archean cratons in the west to the Phanerozoic provinces in the east. The crust and upper mantle of Australia have been deeply investigated in the last two decades using a variety of geophysical methods. To discern temperature and compositional variations in the Australian upper mantle, we apply an integrative technique, which jointly interprets seismic tomography and gravity data. In the first stage, we removed the effect of the crust from the observed gravity field and topography. In the second step, an initial thermal model has been constructed by inverting the seismic tomography model AusREM (http://rses.anu.edu.au/seismology/AuSREM/index.php), assuming a laterally and vertically uniform "fertile" mantle composition. After removing the effect of the temperature variations from the total mantle anomalies, the residual "compositional" fields are obtained. The residual mantle gravity field and residual topography are inverted to obtain a 3-D density model of the upper mantle, which is supplementary to the initial thermally induced density variations. These density anomalies were used to improve the initial thermal and compositional models by applying an iterative approach to account for the effect of composition on the thermal model. The results obtained show that the Precambrian West and North Australian Craton (WAC and NAC) each possess thick, relatively cool, lithosphere that has depleted composition (Mg# > 90). This observation is stronger in the older WAC than the younger NAC. Substantially hotter and less dense lithosphere is seen fringing the eastern and southeastern margin of the continent, resolving the thermal perturbation of these regions in response to Mesozoic and Cenozoic events.

Furthermore, we used the surface heat flow values recently published and the most updated crustal model of Australia (AusREM) to estimate temperature distribution in the crust, assuming steady state conditions, and we used the results obtained together with the mantle thermal model to construct two alternative models of strength and effective elastic thickness (EET) of the lithosphere. The first model (Model I) assumes a constant value of 10−15 s^{-1} for the strain rates. In the second model (Model II), we used the strain rates obtained from a global mantle flow model. In both models we assumed a stiff rheology, on account of the mafic composition of the Australian crust. The results of Model II show larger variability of the rigidity of the plate within the cratonic areas, reflecting the long tectonic history of the Australian plate. On the other hand, the younger eastern terranes are uniformly weak, due to the higher temperatures.