Long period magnetotelluric at the Antarctica: Glacial Isostatic Adjustment imprint in asthenospheric mantle electrical structure. Preliminary results from GOLETA project

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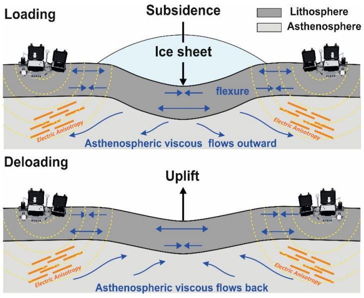

Figure 1. Sketch of GIA process which influence mantle flow. Orange lines mark mantle lineation conditioned by flow direction. Modified from Whitehouse et al., 2019.

INTRODUCTION

The behavior and geodynamic evolution of Antarctica play an essential role in the processes controlling future climatic warming and sea level rise. The tectonic opening of two major oceanic passages, the Drake and Tasmanian gateways, addressed the isolation of the Antarctic continent creating the Antarctic Circumpolar Current around 30-40 million years ago. This change in oceanic circulation doubtlessly affected the global climate and Antarctic ice sheet evolution with consequent sea level change. Mantle rheology influences the motion of lithospheric plates and the Glacial Isostatic Adjustment (GIA) processes. GIA processes imply mantle flows whether from areas of ice accumulation to ice loss zones or towards surrounding oceanic regions. In any case, mantle flows provoke anisotropic behavior of its physical properties including electric anisotropy (**Fig. 1**).

GOLETA project aims to identify and characterize mantle electrical anisotropy in the Northwest Antarctica through assessment of LMT data recorded at fifteen stations distributed along the Shetland Islands and the Antarctic Peninsula (**Fig.2**). All sites recorded at least 15 days and 2 to 3 at the same time allow for a multivariate processing. Two Antarctic Research Campaigns (20021-2022 and 2022-2023) were necessary for data acquisition under the support of the Spanish Polar Program. Here we present preliminary data analysis from some LMT stations addressed by FFMT software (Frankfurt University) suggesting possible presence of electrical anisotropy in the asthenospheric mantle of the Antarctic Peninsula and South Shetland Islands. In this area, it is crucial to account for the tectonic evolution of Antarctica to identify the source of potential mantle anisotropy as a result of geodynamic and /or GIA processes. These results may contribute to the improvement of GIA models currently developed in view of an isotropic mantle.

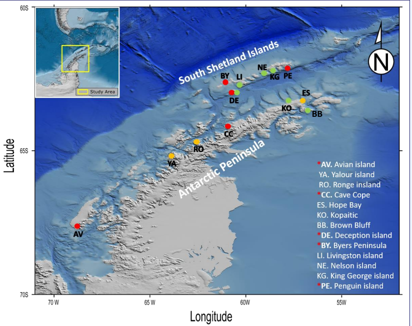

*Figure 2. Location of LMT stations measures in the frame of GOLETA project. Green dots: Antarctic season 2021-2022. Red-orange dots: Antarctic season 2022-2023. Red dots correspond to stations depicted in **Figure 3**.*

MT – Transfer Functions

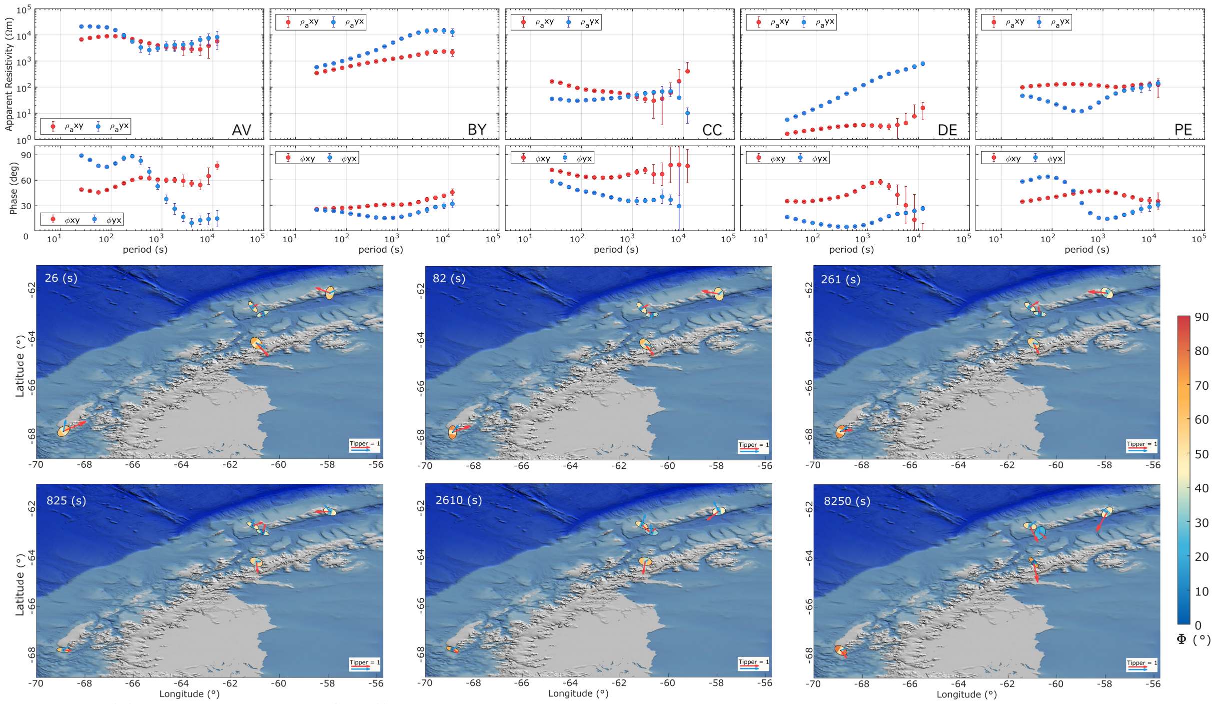

Figure 3. Impedance transfer functions, Phase Tensors and Induction Vectors from AV, CC, DE, BY and PE stations.

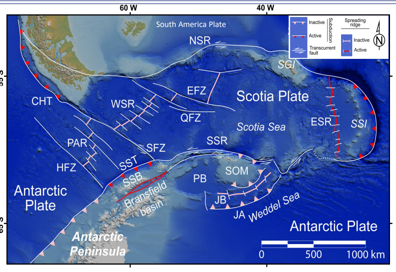

Figure 4. Tectonic setting of the Scotia arc. PAR, Phoenix-Antarctic Ridge; BB, Bransfield Basin; SSB, South Shetland Block; SSR, South Scotia Ridge; SST, South Shetland Trench; CHT, Chile Trench; HFZ, Hero Fracture Zone; JA, Jane Arc; JB, Jane Bank; PB, Powell Basin; SOM, South Orkney microcontinent; WSR, West Scotia Ridge; ESR, East Scotia Ridge; SSI, South Sandwich Islands. b. Tectonic setting of Bransfield Basin. c. Location of MT stations at Deception Island. (Modified from Galindo-Zaldivar et al., 2004 and Morales-Ocaña et al., 2023)

OUTLOOK

These preliminary results highlight the importance of addressing the calculation of 3D electrical resistivity models accounting not only for the ocean influence but also for the main tectonic features (**Fig. 4**). Furthermore, 3D anisotropic modelling will be undertaken to assess the sensitivity of different conductivity scenarios consistent with the geodynamic setting to finally isolate the influence of GIA processes on mantle electrical structure.

Both field campaigns have focussed on the most tectonically active region of Antarctica (West Antarctica). However, the East Antarctica constitutes an old craton with a thick lithosphere making it much more stable (***Fig. 5***). It can be expected that mantle electrical structure in that region will be influenced solely by GIA processes, and the direction of anisotropy would be radial to the continent as suggested by the initial hypothesis of GOLETA project. So that, testing the later would be the next steps in this new line of investigation, providing motivation for future investigations.

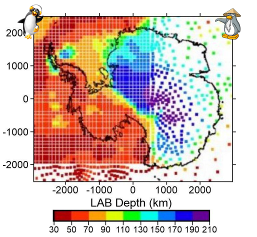

Figure 5. Adjusted elastic lithospheric thickness derived from An et al. (2015a) LAB depths, modified from Nield, 2018.

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