



Tectonic structures on Mercury: kinematics and age dating

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At a global scale, Mercury is dominated by contractional features manifested as lobate scarps, wrinkle ridges and high-relief ridges. Here, we show that some of these features are associated with strike-slip kinematic indicators, which we identified using flyby and orbital Mercury Dual Imaging System (MDIS) data and digital terrain models. We recognize oblique-shear kinematics along lobate scarps and high-relief ridges by means of (1) map geometries of fault patterns (frontal thrusts bordered by lateral ramps, strike-slip duplexes, restraining bends); (2) structural morphologies indicating lateral shearing (en echelon folding, pop-ups, pull-aparts); and (3) estimates of offsets based on displaced crater rims and differences in elevation between pop-up structures and pull-apart basins and their surroundings. Transpressional faults, documented across a wide range of latitudes, are found associated with reactivated rims of ancient buried basins and, in most cases, linked to frontal thrusts as lateral ramps hundreds of kilometres long. This latter observation suggests stable directions of tectonic transport over wide regions of Mercury's surface. In contrast, global cooling would imply an overall isotropic contraction with limited processes of lateral shearing induced by pre-existent lithospheric heterogeneities. Mantle convection therefore may have played an important role during the early tectonic evolution of Mercury.

Estimating absolute model ages for compressional features and comparing it from what it is envisaged with thermal modeling based on cooling alone can be useful in determining if other processes could have been responsible for lobate scarps nucleation. In particular, ages more ancient than the one predicted by the models would imply other kind of tectonic processes ongoing during the early evolution of Mercury.

For this reason, we date an extended thrust system, which we term the Blossom Thrust System, located between 80°E and 100°E, and 30°N and 15°S, and which consists of several individual lobate scarps exhibiting a north-south orientation and a westward vergence.

The age of the system was determined using several different methods. Traditional stratigraphic analysis was accompanied by crater counting of units that overlap the thrust system and by using the buffered crater-counting technique, allowing us to determine an absolute model age for the tectonic feature. These complementary methods give consistent results, implying that activity on the thrust ended between 3.5 and 3.7 Ga, depending on the adopted absolute-age model. Since these ages imply an unexpected early nucleation and end of a major lobate scarp system, the data, if confirmed elsewhere on Mercury surface, would have major implications for models of the thermal evolution and/or tectonic processes of the planet as a whole.