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Relating geodynamic setting to periods of crustal growth and reworking as illustrated by the Phanerozoic granitoids of the Eastern Cordillera of South Peru

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The granitoids that form the backbone of the Eastern Cordillera of Peru between 12 and 14°S, are the ideal material for a case study to relate geodynamic setting to crustal growth over the period of a Wilson cycle. Extension related plutons were emplaced in the back-arc region of the Western Gondwana margin during the Ordovician, Permo-Carboniferous, Triassic and Early Jurassic. With the onset of the Andean cycle in the Middle Jurassic the South American margin was under compression, the plutonic record of this period is in the study area restricted to the Eocene and Miocene.

The Ordovician to Triassic back-arc related plutons share many geochemical characteristics that point to dominant crustal reworking as the main process during their formation. These are 1) their mainly felsic and peraluminous nature; 2) the similarity of whole rock REE and trace element compositions compared to those of average continental crust; 3) the presence of negative Nb-Ta anomalies only in the more evolved samples which indicates that these excursions have been obtained by crustal melting rather than from a slab fluid and 4) the presence of significant amounts of xenocrystic cores in zircon. According to the literature the last major episode of juvenile crust formation was during the Grenvillian age Sunsas event (1.2 – 0.9 Ga) related to the collision of Laurentia and south-western Amazonia during the assembly of Rodinia. Hf-isotopes on zircons from the Ordovician, Permo-Carboniferous and Triassic plutons confirm their origin as mainly crustal melts generated by reworking of Sunsas-age crust. Under these geodynamic conditions it is mainly the crust that melts due to an elevated geothermal gradient as the result of crustal thinning.

However, data from Jurassic nepheline bearing syenite and Eocene hornblende diorite and monzonite have epsilon Hfi values well above those of Sunsas crust, indicating an important mantle component in the melts. The Jurassic geodynamic setting is interpreted as extreme back-arc extension at the verge of spreading, peralkaline, SiO_2-undersaturated syenites formed by small degrees of partial melting of the shallowest asthenospheric mantle but constitute only a volumetrically subordinate magmatic pulse, hence it did not contribute significantly to crustal growth. On the other hand, the Eocene Andahuaylas-Yauri batholith also has an important mantle component in its melt and at the same time is volumetrically the largest magmatic episode in the study area. Therefore we conclude that most Phanerozoic crustal growth took place during this compressional regime related to flat slab subduction. In other words, Eocene melting of the mantle assisted by slab derived fluids was much more efficient than Jurassic decompression melting of a relatively dry mantle during back-arc extension.