New experiments and komatiites vindicate nickel in magmatic olivine as a monitor of mantle lithology

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It was proposed[1,2] that the high abundances of Ni in highly magnesian magmatic olivines indicate that the sources of their host magmas must be free of olivine. This approach was based on a model[3] assuming that Ni partitioning is dependent only on composition of both melt and olivine. These conclusions were challenged by authors[4-7] who invoked a strong temperature dependence of Ni partitioning between olivine and melt and suggested that the Ni excess in olivine is best explained by the temperature difference between the site of ordinary peridotite melting and crystallization of basaltic melts. In view of this controversy, we conducted a new set of 150 experiments (at 1 atm total pressure, 1300-1600ºC, fO_2=NNO±2) with highly precise Ni ol-melt partition coefficients (RSE<1%) to reexamine the compositional and temperature dependence of olivine partitioning. In addition we used new high precision[8] Ni data on olivines from Archean komatiites, which are known to originate in the deep mantle, but have crystallized in the shallow crust and are thus ideally suited to test the temperature dependence of Ni partitioning. We find that the major control on Ni partitioning in olivine is in fact compositional, whereas the temperature dependence is only about half as large as that suggested by refs[5,7]. Thus we are now able to quantitatively account for the effects of both temperature and compositional variations, when assessing the source compositions of mantle-derived melts. The results reinforce the requirement for olivine-free sources in many ocean island basalts and confirm dominantly peridotitic sources for most komatiites.

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