

Ultramafic rocks from the Stalemate Fracture Zone (NW Pacific) dredged during the cruise R/V SONNE SO201-KALMAR Leg 1b

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The Stalemate Fracture Zone (FZ) is a 500 km long SE-NW trending transverse ridge between the northernmost Emperor Seamounts and the Aleutian Trench which originated by flexural uplift of Cretaceous (?) oceanic lithosphere along a transform fault at the Kula-Pacific plate boundary (Lonsdale 1988). Sampling at the Stalemate FZ and the fossil Kula-Pacific Rift valley was carried out during the R/V SONNE cruise SO201 Leg 1b. A broad spectrum of rocks including serpentinites (DR37), gabbro (DR7, 40), dolerites (DR7) and lavas (DR38, 41) were obtained. These rocks are thought to represent a complete section of oceanic lithosphere formed at the fossil Kula-Pacific spreading center. A study of these rocks will allow us to reconstruct the conditions of magma generation responsible for the formation of the NW Pacific oceanic crust and also to characterize the input into the Western Aleutian subduction zone. Here we report first results on the composition and origin of serpentinites dredged from the Stalemate FZ at the station DR37 (Fig. 1).

According to on-board description and petrographic investigations we distinguished two major groups of samples: (1) pyroxene-rich lherzolites and (2) pyroxene-poor dunites. All studied rocks were serpentinitized to 80-100%. Strong imprint of the secondary alteration on the rock compositions is also evident from our preliminary ICPMS data on trace elements in the bulk rocks. These data show strong enrichment of the serpentinites in fluid mobile elements (U, Li, Sb, Ba) and U-shaped patterns of REE with strong negative Ce anomaly suggesting extensive seawater-rock interaction overprinted most primary geochemical features of the rocks.

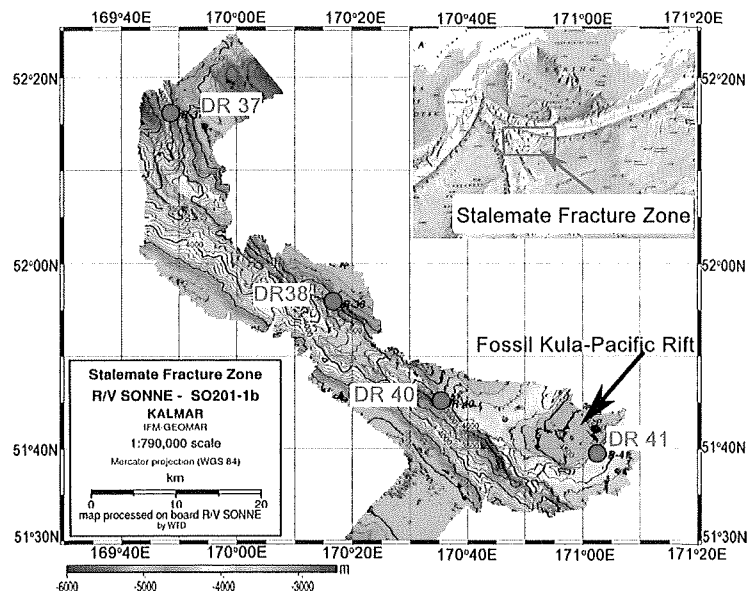


Fig. 1.: Overview map of the northern part of the Stalemate Fracture Zone and SO201-KALMAR Leg 1b dredge locations.

In order to reconstruct initial compositions of the studied peridotites, relics of primary minerals (spinel, clinopyroxene and orthopyroxene) were analyzed by electron probe JEOL 8200 at the IFM-GEOMAR. We found that the compositions of the primary minerals change systematically from lherzolites to dunites. Spinel in lherzolites has higher Mg#, NiO, lower Cr#, Fe³⁺# and TiO₂ (Mg#=0.65-0.68, NiO=0.26-0.34%, Cr#=0.26-0.33, Fe³⁺#=0.021-0.030, TiO₂=0.04-0.09 wt%) than spinel in dunites (Mg#=0.56-0.64, Cr#=0.38-0.43, TiO₂=0.19-0.28 wt%, NiO=0.19-0.26%, Fe³⁺#=0.027-0.043) (Fig. 2). Clinopyroxene in lherzolites is moderately Mg- and Ni-rich, Ti- and Na-poor and has lower Cr# (Mg#=91.7-92.4, Cr#=0.12-0.16, TiO₂=0.06-0.15 wt%, Na₂O=0.19-0.41 wt%, NiO=0.06-0.09 wt%) compared to clinopyroxenes analyzed in a sample of dunite DR37-3 (Mg#=93.7, Cr#=0.16, TiO₂=0.23 wt%, Na₂O=0.85 wt%, NiO=0.06 wt%). Orthopyroxene preserved in lherzolites has narrow compositional range (Mg#=90.3-90.9, Cr#=0.10-0.12, TiO₂=0.02-0.05 wt%, Na₂O=0.01-0.025 wt%, NiO=0.12-0.17 wt%). In general, the mineral compositions form continuous trends with end-members represented by lherzolite DR37-13, on the one side, and dunite DR37-3, on the other side. Minerals from lherzolite DR37-6

have transitional compositions between those in predominant lherzolites and dunites (Fig. 2).

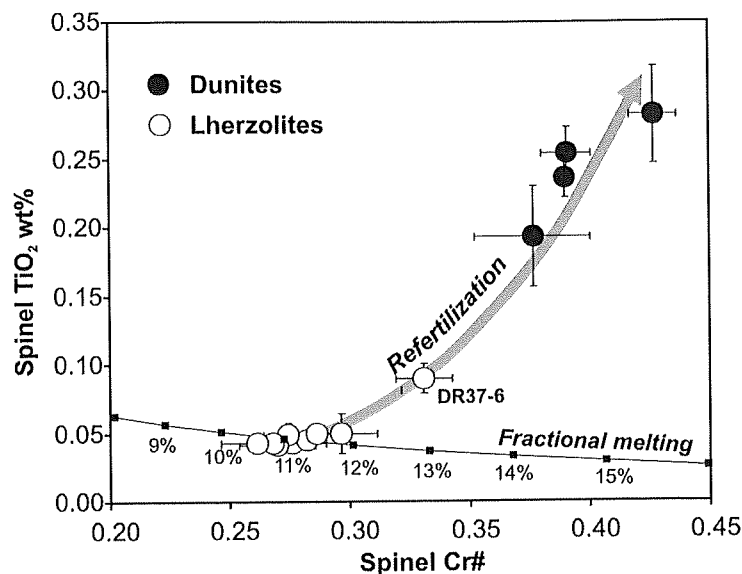


Fig. 2.: Composition of spinel in lherzolites and dunites from the Stalemate FZ. The positive correlation of Cr# and TiO₂ in spinel can be explained by two-stage process: (1) depleted mantle melted fractionally to 10-12%, (2) the residual lherzolite interacted with Ti- and Cr-rich melts (refertilization trend) to form dunites.

The continuous array of mineral compositions suggests close genetic relationships between the lherzolites and dunites. Compositions of minerals in lherzolites are similar to those from the Mid-Atlantic Ridge (e.g., Dick et al., 1984) and suggestive that the lherzolites are mantle residues after melt extraction at mid-ocean rift, possibly, at the Kula-Pacific Rift. As illustrated in Fig. 2, the spinel composition in lherzolites corresponds to 10-12% of fractional melting. Compositions of spinel and pyroxene from dunites deviate strongly from the expected trend of partial mantle melting and require alternative explanation. A possible model to explain the occurrence of dunites in close association with residual lherzolites in the Stalemate FZ could be reactive interaction of shallow residual mantle with deeper Ti- and Cr-rich melts. This process should lead to dissolution of pyroxenes in lherzolites and is thought to form an interconnected network of dunite channels serving as pathways for melts to the surface (Kelemen et al., 1995). The

separate pieces of lherzolites and dunites dredged from the Stalemate FZ can thus represent disintegrated parts of shallow oceanic mantle strongly modified by melt percolation. Further studies of trace element systematics of the peridotite minerals will allow us to refine this model and to estimate the composition and nature of the percolated magmas. The results are anticipated to bring important constraints on the composition and evolution of the upper oceanic mantle in the NW Pacific.

References

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