show that: (1) all are characterized by large concentrations of ilmenite (Ilm>>Gt>>>Px) with Mali>Liberia>Guinea>Sierra Leone; (2) Antoschka (Guinea) exhibits the largest variety of opaque minerals (Ilm+Rut+Sp); (3) Mali is characterized by low T anatase+Hem replacement of Ilm, and Sierra Leone has abundant sulfides (Cpy+Po+Pn) within Ilm; (4) extremely large (10-15 cms) Ilm are derived from Liberia; (5) Sierra Leone and isolated sites in Liberia have high MnO (16wt% max) contents in Ilm associated with calcite; (6) large variations and considerable overlap exist within and between kimberlite clusters in Ilm-Geik-Hem contents; (7) subsolidus reduction of Ilm to 2 $Ilm_{ss}+Sp_{ss}$ is unique to Sierra Leone whereas exsolution of Ilm_{ss} from Ilm-Geik-Hem_{ss} are restricted to Liberia and Antoschka; (8) Cr_2O_3-MgO variations are either tightly clustered along a parabolic curve delineated by $Mg_{Ilm}\lesssim Mg_{sp}$ or dispersed within a broad hyperbolic envelope; (9) a coherent pattern of compositional variations is established between Ilm-Ilm_{ss} pairs which define a decompositional loop in the ternary Ilm-Geik-Hem that is consistent with experimental data at variable T-fO_2; and (10) by using the data from (9) and combined with Ilm compositions from southern Africa it is concluded that the dominant control on Ilm compositions is the T-fO_2 dependency of immiscibility within the system Ilm-Geik-Hem, such that Ilm-Hem_{ss} and Ilm-$Geik_{ss}$ are permissible, Geik-Hem_{ss} are absent, and intermediate (Ilm-Hem)-(Geik-Hem)$_{ss}$ are restrictive because Sp_{ss}+(Pb+Kar+FPb)$_{ss}$ is stable at low P.

D27

COMPLEX TITANATE COMPOUNDS (MO_2, M_2O_3, M_3O_5, M_4O_7, $M_{22}O_{38}$) IN KIMBERLITES: MINERAL REPOSITORIES FOR AND THE PARTITIONING OF LIL ELEMENTS.

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The mineralogy and genesis of components hosting large concentrations of (R) refractory (e.g., Cr,Nb,Ta,Zr) and LIL (e.g., K,Ba,Sr,REE) elements in kimberlites and kimberlite nodules provide insights to the nature of mantle reservoirs, may be used to impose constraints on degrees of partial melting, and may yield independent estimates of originating depths and sites of equilibration. R and LIL are abundant in rutile (MO_2), perovskite (M_2O_3), armalcolite-related (M_3O_5), zirconolite (M_4O_7), and crichtonite-related ($M_{22}O_{38}$) minerals. However, with the exception of MO_2(TiO_2II) none of these compounds have established high P stabilities. It is proposed that substitution of Cr,Zr, and Nb into TiO_2 may be accomplished in compounds related to the high P parent structure αPbO_2 by

crystallographic shear (CS) comparable to those in the series MnO_{2n-1} - MnO_{3n-2} (n=1,2,3) and to $Cr_2Ti_{n-2}O_{2n-1}$ (n=3,4,5). Such compounds, on ascent-equilibration, yield a viable explanation for the occurrence of M_3O_5 (armalcolite type) in association with rutile and ilmenite, and for the ubiquitous presence of rutile and ilmenite intergrowths. Ba-K (Sr,Pb,Ca,REE) members of $M_{22}O_{38}$ compounds decompose to rutile+spinel+X....n phases suggestive of site occupation of LIL at high P into phases other than CS based structures. Using the model precursors of CS and non-CS structured compounds (i.e., αPbO_2 and $M_{22}O_{38}$) and constrasts in paragenesis, two distinct R + LIL evolutionary trends emerge: (a) in which Nb+Zr+Cr+K are complexed as high P incompatible liquid residua into MO_2, M_4O_7 ($Cr_2Ti_2O_7$) or $M_{22}O_{38}$ type compounds in nodules; and (b) low P melt residua in which Ti fractionates to form R-depleted ilmenite and a Ti+REE sink in perovskite at the terminal stages of kimberlite crystallization.

D28

A LAYERED DUNITE – WEHRLITE – WEBSTERITE FROM NEWLANDS, SOUTH AFRICA; EVIDENCE FOR SMALL SCALE FRACTIONAL CRYSTALLIZATION IN THE MANTLE.

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A layered mantle xenolith, LDN-10, has been found in the Newlands kimberlite. The bulk composition, calculated from modal mineral proportions, approximates a peridotitic Komatiite. The following layers are recognised: a) Dunite b) Wehrlite c) Gt-Wehrlite d) Gt-Websterite. Olivine and orthopyroxenes show minor chemical variations across the xenolith. The garnets and clinopyroxenes are strongly zoned, particularly with respect to Cr_2O_3, which also decreases systematically from the wehrlitic layers to the websteritic layer.

The layering in LDN-10 can be interpreted in terms of a fractional crystallisation model that is consistent with phase relations established for the CMAS tetrahedron (O'Hara, 1968). In this model, with a liquid corresponding to the bulk composition for LDN-10, the first mineral phase to crystallise will be olivine, followed by clinopyroxene, garnet and orthopyroxene respectively. This crystallisation sequence is reflected by the observed mineral assemblages in LDN-10 and is consistent with the observed Cr_2O_3 variation of both clinopyroxene and garnet.

Gurney et al (1975) proposed a fractional crystallisation model for the Matsoku xenolith suite. It is suggested that LDN-10 represents a similar type of mantle process, but on much smaller scale.

References:
Gurney J.J., Harte B., and Cox K.G. 1975: Phys. Chem. Earth 9, 507-523.
O'Hara M.J.,1968: Earth Sci.Rev. 4, 69-133.

(Late abstract)
MANTLE MINERAL ASSEMBLAGES AND PALAEOGEOTHERMS

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Many recent studies of the quenched mineral assemblages in magmas considered to have a deep mantle origin (alkali basalts and kimberlites) and their enclosed nodules, have sought to determine the depth at which the mineral geothermometers closed to further reequilibration. If the deduced P-T-points lie on a curve, then they are frequently interpreted to define the P-T-location of a palaeogeotherm. If the deduced P-T-points form an array, then uncertainties in P-T-calibra-

tion of a simplified chemical system (or the in-
herent problems in extrapolating from simple to
complex crystalline solutions) are introduced to
accommodate a desired palaeogeotherm. The hypo-
thetical "Kinked or perturbed" palaeogeotherms
have been straightened by some authors on grounds
of mineralogical problematics. Likewise, more re-
cent studies have shown that the deduced P-T-
equilibration conditions for sheared or unsheared
nodules are only mutually exclusive. Even if we
take the generous and pragmatic viewpoint that
deduced P-T-points from quenched magmas and their
nodules do not reflect reequilibration en-route
to the surface, we are still faced with the prob-
lem of what the nodules represent with reference
to the enclosing magma and whether the P-T-cond-
itions are anomalous in the long-term evolution
of the mantle.

We have attempted to use trace element and
other geochemical indicators together with con-
straint on mantle metamorphism and melting in a
framework governed by time-dependent convective
instability in the mantle, to consider, among
other characteristics, the age clustering of kim-
berlites (or their nodules, their location in
crustal fracture zones and the distinctly dif-
ferent depths of alkali basalt versus kimberlite
magma genesis.

Field trip in the Lesotho highlands after the Cape Town conference
Photo C. Froidevaux