volcanic province where only alkali basalts occur, usually bearing high-pressure phases (megacrysts, spinel-garnet pyroxenites of the Al-Ti-augite group, spinel-peridotites and at Eglazines also spinel-garnet pyroxenites and spinel-garnet peridotites).

Two new geothermometers, one new geobarometer and one new "oxygen fugacitimeter" are used in this study.

The pyroxenites include spinel-free pyroxenites equilibrated from 1160 to 1220 C°, spinel websterites (1000 → 1050 C°) and spinel-garnet pyroxenites. Spinel peridotites are composed of two groups. The former consists of coarse-grained peridotites equilibrated near 1000 C° ($fO_2 \simeq 10^{-10}$ atm.) the latter group is composed of peridotites (1200 → 1250 C°) reminding of some porphyroclastic peridotites from kimberlite xenoliths of South Africa.

The spinel-garnet peridotites plot into the lherzolite field. Thin section observations suggest that spinel is not the result of an resorption (by lowering of pressure) of an earlier garnet-bearing rock. Therefore these xenoliths may be assigned to the spinel-garnet boundary. It would have equilibrated near 25 kb at a temperature of some 1230 C° ($fO_2 \simeq 10^{-95}$ atm.).

D14

PERIDOTITES FROM THE OLMANI SCORIA CONE, N. TANZANIA

A.P. JONES, J.B. DAWSON, J.V. SMITH
Department of Geophysical Sciences,
University of Chicago, Illinois 60637,U.S.A.

Basaltic scoria of the Olmani volcano, 10km SE of Arusha, N. Tanzania, contains blocks of dunite, harzburgite, lherzolite and diopside-rich wehrlite. The texture of most is porphyroclastic; large (>1cm) deformed olivine grains exhibit multiple planar extinction discontinuities, and there is abundant evidence for grain-boundary migration between adjacent deformed grains; subgrains are also developed. In orthopyroxenes, exsolution of opaque platelets takes place at extinction discontinuities. Large olivines are forsterite (Fo_{92-93}), but smaller re-crystallized, strain-free grains are more Fe-rich (Fo_{88}). Enstatite (En_{90-92}) is low in Al_2O_3 (1-2wt %) and Ca (0-0.4), Both enstatite and Cr-diopside ($\underline{mg}$ 0.93, up to 2.2% Na_2O, up to 3.2% Cr_2O_3) may occur in "fingerprint" intergrowths with Mg-chrome spinel (MgO 12-15%, Cr_2O_3 52-66%). Fine-grained material (?devitrified glass) associated with some cpx-chromite intergrowths is K-rich (4.7-5.7%) and very variable in composition (e.g. SiO_2 46-54%, MgO 4-19%, CaO 1-3%) and with low totals (?hydrous). In one specimen high-Na glass of variable composition (e.g. Na_2O 6.2-8.2%, K_2O 2.7-4.0, SiO_2 44.2-49.9) but apparently anhydrous (totals 98.4-101.3), has developed adjacent to cpx grains. The development of these alkali-rich basic melts from upper mantle material may be significant in models for the alkali-basalt province of N. Tanzania

D15

GARNET LHERZOLITE AND OTHER INCLUSIONS FROM A BASALT FLOW, BOW HILL, TASMANIA

F.L. SUTHERLAND, J.D. HOLLIS, L.M. BARRON
Department of Mineralogy and Petrology, The Australian Museum, 6-8 College Street, Sydney, Australia 2000

Garnet lherzolite xenoliths at Bow Hill, Tasmania are a rare occurrence from a basalt flow. Such xenoliths are known from alkali basalt (mainly breccias) in France, U.R.S.S., Mongolia, Patagonia, Japan, Hawaiian Islands and E. Australia. The Tasmanian examples occur with garnet websterite, spinel lherzolite, spinel websterite, spinel wehrlite and crustal inclusions. Statistical counts give a ratio of garnet lherzolite to spinel lherzolite of about 1 to 500 and between 60-75 % peridotites, 5-10 % pyroxenites and 20-30 % crustal rocks for the suite. Apart from cumulate spinel wehrlite, the ultramafic inclusions represent accidentally derived mantle material.

The garnet compositions ($Mg_{70-78}Fe_{13-18}Ca_{8-13}$) lie at the magnesian extreme for E. Australian basaltic and kimberlitic inclusions. They occur with Al orthopyroxene ($Mg_{83-89}Fe_{9-14}Ca_2$), Al clinopyroxene ($Mg_{52-54}Ca_{38-41}Fe_{4-9}$) ± olivine ($Mg_{90-93}$). Compositions are based on micro-probe analyses with total Fe as Fe O.

The host nepheline hawaiite belongs to a Tertiary, mafic K-rich alkaline lineage in Tasmania. The megacryst and cumulate minerals include olivine (Mg_{82}), Al clinopyroxene ($Mg_{42-46}Ca_{44-49}Fe_{9-11}$) and spinel ($Mg_{85}Fe_{35}$). Chemical mixing by addition of observed proportions of these compositions suggest that the host evolved by 20 % crystallisation of wehrlite from a primary parental basanite. Similar basanites are found in the area.

P-T estimates for the garnet lherzolite and garnet websterite from a variety of geobarometers and geothermometers range between 17-31 kb and 1130-1320°C. (Carswell and Gibbs, 1980, Nodmins programme ; Herzberg, 1978). This data indicates an origin in the mantle lying without the diamond stability zone. The lower P-T values may be the more realistic as they match experimental sub-liquidus crystallisation of wehrlite minerals from compositions related to the parental basanite (< 26 kb, 1300°C ; Arculus, 1975).

The xenolith assemblages allow a composite reconstruction of the lower crust and upper mantle under central Tasmania. The mineral compositions demonstrate the care needed to distinguish true kimberlites from basaltic occurrence, using similar indicator minerals.

Arculus R.J., 1975 Carnegie Inst. Washington Yearb,74,512-515
Carswell D.A., Gibbs G.F.G., 1980 Contrib. Mineral Petrol, 74 403-416
Herzberg C.T., 1978 Geochim.Cosmochim.Acta., 42, 945-957

D16

PETROLOGY AND GEOCHEMISTRY OF MANTLE ECLOGITE XENOLITHS FROM COLORADO-WYOMING KIMBERLITES

P.C. ATER, M.E. McCALLUM and D.H. EGGLER
Department of Earth Resources, Colorado State University, Fort Collins, Colorado 80523 ;

Eclogite xenoliths from Colorado-Wyoming kimberlites can be divided into two groups based essentially on absence or presence of kyanite and(or) corundum, and corresponding metaluminous or peraluminous character. Metaluminous eclogites generally are granoblastic and contain one or more of the accessory phases rutile, sanidine, graphite, quartz and sphene. Peraluminous eclogites commonly are foliated or layered and may contain accessory rutile and sanidine. Compositions of clinopyroxene and garnet overlap between the two groups; however, clinopyroxenes in peraluminous xenoliths generally are higher in jadeite and Ca-Al components, whereas garnets are higher in grossular component and lower in almandine. Equilibration temperatures, calculated from Fe-Mg partitioning between clinopyroxene and garnet, range from 794°C to 1163°C for an assumed pressure of

30 kilobars. Normative bulk compositions of the eclogites are equivalent to picrite, olivine tholeiite, alkali olivine basalt, basanite and basaltic anorthosite. Compared to equivalent phases precipitated from laboratory melts, eclogite clinopyroxenes contain higher jadeite and SiO_2 and lower Ca-Tschermak molecule, whereas garnets contain higher grossular. Eclogite bulk compositions are dissimilar to those of mafic liquids derived by partial melting of mantle peridotites. Eclogites contain higher Al_2O_3, Na_2O and locally K_2O, and lower MgO and Cr_2O_3. Such compositions are similar to those of clinopyroxene + garnet $\pm$ kyanite $\pm$ feldspar cumulates precipitated from tholeiitic and calc-alkaline laboratory melts. Chemical compositions support the hypothesis of Green and Ringwood (1967) that the eclogites may be metamorphosed residua and cumulates from partially melted subducted oceanic crust. (Study supported by Earth Sciences Section of NSF, Contract EAR-7810775)

D17

ILMENITE IN UPPER MANTLE POLYMICT XENOLITHS FROM BULTFONTEIN

LAWLESS, P.J. and *WYATT, B.A.*
Anglo American Research Laboratories,
P O Box 106, Crown Mines, 2025, S.A.

Four polymict deformed xenoliths from Bultfontein, each of which have a strong disequilibrium garnet lherzolitic mineralogy, also contain abundant ilmenite. The ilmenite occurs either as transgressive veins or as isolated patches and 'blebs' and is closely associated with phlogopite and often rutile as well as occasional sulphides. The ilmenite in the various xenoliths broadly have similar compositions being characterised by high but variable Cr_2O_3 (1-5 wt.%) contents and relatively constant and high MgO (14-15 wt.%) contents, while the rutile is also often enriched in Cr_2O_3 (3-4 wt.%). Where the ilmenite occurs as veins, which are clearly intrusive into the xenoliths, the smaller veins and the edges of the larger veins invariably have the higher Cr_2O_3 contents, perhaps in response to temperature variation during crystallisation. No armalcolite has been found which is suggestive of a high pressure (more than 20 kb) paragenesis for the ilmenite. The mineral chemistry of the ilmenite and rutile is described in detail and is also compared to xenocrystal material and available experimental data. This information is used to develop a possible phenocrystal model of formation for the majority of the ilmenite which occurs in kimberlite.

D18

PETROLOGY AND GEOCHEMISTRY OF ULTRAMAFIC XENOLITHS FROM THE GERONIMO VOLCANIC FIELD

P.D. KEMPTON, M.A. DUNGAN, M.A. MENZIES
Department of Geological Sciences, Southern
Methodist University, Dallas, Texas, USA

Ultramafic xenoliths included in Plio/Pleistocene alkali basalts from the Geronimo Volcanic Field (GVF) record a multistage evolution for the mantle beneath SE Arizona. The dominance of unfoliated, granuloblastic, Type I harzburgites and clinopyroxene-depleted spinel lherzolites at GVF supports the occurrence of a major depletion event in the mantle followed by a period of re-equilibration. The coherence of major element mineral chemistry data indicates that variation in bulk rock major element chemistry among the xenoliths is a function of modal mineral abundances and that equilibration conditions were relatively uniform. Variation in Fe/Mg and REE abundances indicates different degrees of depletion among the xenoliths. INAA analyses of REE in cpx from cpx-rich spinel lherzolites have high, LREE-enriched patterns while cpx from depleted (cpx-poor) spinel lherzolites and harzburgites may be as much as an order of magnitude lower in REE.

Composite xenoliths are abundant and of two types: 1) websterite or diopside veins in spinel lherzolite, and 2) Type II clinopyroxenite cross-cutting wehrlite or spinel lherzolite. Chemically, the Type II clinopyroxenites are distinguished from the Type I xenoliths by higher Al, Ti, Ca and Na, but lower Mg. They typically possess igneous textures in which cpx subpoikilitically to poikilitically encloses olivines and probably formed as the crystallization of magma in dikes or conduits under mantle conditions.

Kaersutite peridotites, similar to the Type II spinel-bearing clinopyroxenites, are locally abundant. The kaersutite commonly forms large, cm-sized, optically continuous crystals which partially replace clinopyroxenes of varying crystallographic orientations. The origin of the amphibole is enigmatic, but may represent the final, fluid-rich stage of crystallization of magma trapped at depth.

D19

TWO-PYROXENE INTERGROWTHS FROM SOUTH AFRICA

ROBERT H. MCCALLISTER and *HENRY O.A. MEYER*
Department of Geosciences, Purdue University,
West Lafayette, Indiana 47907, U.S.A.

Megacrysts consisting of two-pyroxene intergrowths in which one of the phases has obviously exsolved from the other have been investigated. These megacrysts were obtained from Koffiefontein, and the Bellsbank area kimberlites. All previous studies of megacrysts to date have been for the most part on discrete mineral grains. Conclusions made from such studies are based on the assumption that the discrete megacrysts may have formed in equilibrium. In the case of the 2-pyroxene intergrowths no assumption is necessary as it is a fact that the two phases have equilibrated together.

The pyroxenes forming the intergrowths are typically diopside-enstatite. In some instances minor garnet either as lamella or rounded blebs is present. Either enstatite or diopside may be the host with the other mineral occurring as the exsolved phase. All analyses of the clinopyroxenes and orthopyroxene pairs were used in determining pressures and temperatures of equilibration via the computer program TEMPEST. Temperature (Lindsley and Dixon, 1976) versus pressure (Wells, 1977) plot for the Bellsbank intergrowths define a geotherm generally similar to ones suggested for other kimberlites in the region. It appears that most of the intergrowths have cooled to the geotherm and there is little evidence for abnormal temperature environ-