EUG XI

Symposium MS06

Oceanic Large Igneous Provinces

Convenors

Nicholas Arndt
Malcolm Pringle

Wednesday PO Session

MS06 : WEpo01 : PO
Did the Hawaiian Plume Interact with a Mid-Ocean Ridge in the Late Cretaceous?

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Keller et al. (2000) showed that Detroit seamount (81 Ma) has a MORB-like composition which is unlike younger Hawaiian and Emperor seamount lavas. They therefore suggested that the Hawaiian plume interacted with a mid-ocean ridge during its earliest stages of evolution ~80 m.y. ago. Regelous et al. (2000) contest this model and suggest that either the composition of the mantle sampled by the plume has changed with time or that differences in lithospheric thickness (which have also varied with time) control the extent of decompression melting of the underlying plume.

Differentiating between these alternative hypotheses depends on unambiguous recognition of the mantle components involved. Particularly important is distinguishing between depleted upper mantle (normal MORB-source) and a depleted component intrinsic to the plume. Plots of Zr/Y vs Nb/Y have proven useful in this regard in studies of Iceland. In this diagram, Hawaiian and Emperor lavas form an array with a similar slope, but they tend to plot near to or below the lower bound for Iceland. Nonetheless, most Detroit samples plot above the MORB field, suggesting that the Hawaiian plume may, like Iceland, contain a depleted component distinct from N-MORB.

Similarly, on a plot of $^{207}Pb/^{204}Pb$ vs. εNd, Pacific MORBs (including Mesozoic Pacific MORB) form an array with a negative slope. Individual Hawaiian islands form discrete fields with $^{207}Pb/^{204}Pb$ values similar to MORB, but trend towards progressively lower εNd values. In contrast, Emperor seamount samples have εNd values higher than most Hawaiian lavas but lower than MORB, and form a trend parallel to the MORB array, i.e. MORB does not appear to be a reasonable end-member for either the enriched or depleted end of the trend.

New Hf isotope data show that most Emperor seamount samples overlap the radiogenic (i.e. “depleted”) end of the array formed by recent lavas from the Hawaiian islands in εNd vs. εHf, but the two Detroit samples extend this array to more depleted compositions. Although the Detroit data plot in the region between the Iceland and N-MORB fields, they do not obviously trend toward the composition of Mesozoic Pacific MORB. Furthermore, Blichert-Toft et al. (1999) observed that the trend of data for individual Hawaiian volcanoes has a shallower slope than that of the overall OIB array, and attributed this to mixing with pelagic sediments. In contrast, the trend of the Emperor seamount data has a steeper slope, similar to Iceland. Collectively, the data suggest that the Hawaiian plume may contain a depleted component that is distinct from Pacific MORB-source mantle.

Keller, R. A., Fisk, M. R. & White, W. M., *Nature*, **405**, 673-676, (2000).
Regelous, M., Hofmann, A. W., Abouchami, W. & Galer, S. J. G, *J. Conf. Abs.*, **5**, 832, (2000).
Blichert-Toft, J., Frey, F. A., & Albarede, F., *Nature*, **285**, 879-882, (1999).

MS06 : WEpo02 : PO
The Diamantina Rift Zone: New Evidence from Geochemistry

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The southern margin of Australia is marked by the presence of a number of parallel basement ridges. One of them, the Diamantina Zone has been studied during the Marion Dufresne MD110 -MARGAU cruise in June 1998 in order to collect more information on the opening of the Indian Ocean and breaking-up of the continental lithosphere in this region. Peridotites, gabbros and basalts have been recovered during that cruise.

In this study we focuse on the basalts and fine-grained dolerites dredged S and SE of the Naturaliste Plateau. These rocks are generally highly altered but occasionally well-preserved samples bearing fresh olivine can be found. Basalts are either fine-grained, microporphyritic and mm-size olivine-bearing (Fo_{86} with Cr-spinel inclusions), or macroporphyritic with large cm-size plagioclase phenocrysts (An_{86-78}). Groundmass may be mainly glassy, or show quenched plagioclase (An_{70}) and more rarely granular clinopyroxene. Dolerites are rarely well preserved, plagioclase is partly altered but clinopyroxene is fresh.

Major element chemistry shows large scatter in relation with water-rock interaction. However, some samples are MgO-rich (up to 9.8%) and their low K_2O contents (0.3) are suggestive of a tholeiitic nature. Samples display REE patterns with $(La/Yb)_N$ between 1 and 3.5, which are analogous to both OFB-basalts from Kerguelen-Plateau recovered during the leg ODP120 and CFB-basalts from Bunbury, Western Australia. Additionally, one of the sites, on the edge of the Naturaliste Plateau, also displays a second type of pattern with similarly flat Eu-Lu patterns but enriched LREE. Sr and Nd isotope data (after leaching) of the least evolved samples along with Th/Ta and La/Nb ratios are different from N- and E-MORB. They show strong evolution from E to W (from ε Nd >4 in the E to -11 in the W) and are correlated with Nb/La ratios that range from 1 to 0.36, rocks with the LREE enriched patterns having the most radiogenic Sr isotopic values. These relationships are strongly suggestive of contamination by old continental crust. Between the two possible interpretations of the Diamantina Zone from geophysical evidence, either a very low spreading ridge or the axial zone of a rifted continental margin, these new geochemical data are in favor of the second.

MS06 : WEpo03 : PO
Two Distinct Cretaceous Oceanic Plateaus in Ecuador: Implications for the Geodynamic Evolution of the Andean Margin

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Two distinct assemblages of oceanic plateau affinity are exposed in western Ecuador. In the Western Cordillera, the oldest and easternmost assemblage is Early Cretaceous in age. It consists of: (i) ultramafic and mafic cumulates (123 Ma; San Juan section), and (ii) pillow basalts and dolerites intruded by shallow level gabbroic stocks (Merced-Multitud section) which accreted to the continental margin during the Late Cretaceous. Isotopic geochemistry suggests that they developped in a near-ridge centered environement. Father west (Guaranda section), the youngest oeanic plateau assemblage is composed of high Mg-basalts and picrites which collided to the Ecuadorian margin during the Latest Cretaceous. The Ecuadorian high Mg-basalts and picrites share with the 90-86 Ma high Mg-mafic lavas of the Caribbean Colombian Oceanic Plateau (CCOP) similar trace element and isotopic chemistry (highly depleted picrites, Enriched basalts with HIMU component) but differ from the Early Cretaceous oceanic plateau rocks (OPB) from Ecuador by significantly higher Pb ratios. These two oceanic plateau assemblages are also exposed in coastal Ecuador. The basalts and dolerites of the Pi-on Formation exposed in Southwestern Ecuador (Guayaquil) are geochemically similar to the Merced-Multitud mafic rocks. The picrites, basalts and dolerites exposed farther north, near Pedernales and Esmeraldas are geochemically similar to the Upper Cretaceous rocks of the CCOP (eg. Gorgona Island). Thus, during the Late Cretaceous, two different oceanic plateaus collided successively to the Ecuadorian passive margin: an Early Creaceous near-ridge centered plateau and the CCOP. The presence of these two distinct plateau assemblages both in the Western Cordillera and in the coast, suggests that these terranes have been laterally doubled by means of large scale dextral strike-slip faults.

MS06 : WEpo04 : PO
Structure of the Cretaceous Kerguelen and Mod-Astrid Volcanic Provinces from Magnetic Anomaly Data

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The magnetic anomaly map of the southern Indian Ocean compiled within the Antarctic Digital Magnetic Anomaly Project (ADMAP) contains many imprints of major tectonic elements and displays their regional characterizations. Abrupt changes in magnetic anomaly expressions along the oceanic-continent transition are clearly defined on the map. The colour-shaded relief map also illustrates the anomalous character of seafloor magnetic anomalies over the southern margin of the Kerguelen Plateau and in the Riiser Larsen Sea over the Maud Rise and the Astrid Ridge. Both regions are characterized by some of the largest (more then 2000 nT) magnetic anomaly amplitudes observed over offshore area and might be interpreted as stretched continental fragments overlain by basaltic flows isolated from (southern Kerguelen Plateau & Maud Rise) or attached (Astrid Ridge) to the Antarctic margin. Magnetic anomaly pattern clearly evidenced that magmatic intrusion contributions are important. The observed differences in anomaly trends might be explained by a tectonic origin and are consistent with the extension of the SKP crust in the NNW-SSE direction and for the Maud Rise - Astrid Ridge crust in the NNE-SSW direction. Magnetic data suggest that at least 300 km of the Enderby Basin is a part of the Cretaceous Kerguelen Volcanic Province that it interpreted as a result of influence of the Kerguelen plume. Similarities of magnetic patterns of two remote regions are obvious and allow to consider the Maud Rise - Astrid Ridge region as a submarine large igneous province.

MS06 : WEpo05 : PO
The Effect of fO_2 on the Differentiation of LIP-basalts from the Kerguelen Archipelago. An Experimental Study

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Phase relations of three natural rock samples from the large igneous province? Kerguelen Plateau have been investigated experimentally to understand the effect of f_{O2} on the differentiation path of LIP-basalts. The starting materials, one alkali basalt from the Mt. Crozier (Damasceno et al., 1997), one tephri-phonolite and one phonolite from the Ronarc´h Peninsula (SE Province) show the typical geochemical signature of the Kerguelen plume (Weis et al., 1993). The comparison of the natural phenocryst assemblage with the experimental products are used to constrain the differentiation and pre-eruptive conditions of these magmas. Equlilibrum crystallisation experiments were performed using dry glasses, water and $Ag_2C_2O_4$ (source for CO_2) as starting materials. Various X_{H_2O} were used to change the water activity during the experiments. Experimental conditions: Internally-heated-pressure-vessel (IHPV) equipped with a rapid-quench system and Shaw-membrane technique used to control the oxygen fugacity for the runs with the basalt; cold-seal-pressure-vessels (CSPV) filled with water or argon to control the oxygen fugacity for the experiments with the tephri-phonolite and the phonolite; P = 200 MPa - 500 MPa; T = 740°C - 1100°C; X_{H_2O} = 1.0 - 0.4; log fO_2 = NNO - NNO+3.7. The experimental results show that the oxygen fugacity has a significant influence on the stability of ferro-magnesian phases and the tectosilicates. With decreasing the fO_2 from NNO to NNO+2.3 the alkali feldspar saturation temperature is depressed by 40°C in the phonolite. At oxidizing conditions (log fO_2 ~ NNO+2.3) the fractionation of feldspars (plagioclase and/or sanidine) can produce residual melts that have higher alkali contents than at reducing conditions (log fO_2 ~ NNO). Preliminary results with the alkali basalt show that at oxidizing conditions

(log fO_2 = NNO+3.7) olivine is not stable (magnetite is the main liquidus phase). In contrast, olivine is the main liquidus phase in MORB basalts at the same fO_2.

Damasceno D, Nicolaysen K, Weis D, Scoates J, Frey FA, Yang HJ & Giret A, *EOS*, **78**, (1997).
Weis D, Frey FA, Leyrit H & Gautier I, *Earth Planet. Sci. Lett*, **118**, 101-119, (1993).

MS06 : WEpo06 : PO
The Val Gabbro Revisited, Kerguelen Archipelago: Evolution of a Plutonic Complex in an Oceanic Island and Relations with Volcanic Rocks

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Like some other oceanic islands (Iceland, Galapagos, Reunion), the 6500 km^2 Kerguelen Archipelago in the southern Indian Ocean contains numerous plutonic complexes. These complexes intrude the 30-24 Ma tholeiitic to alkaline flood basalts that represent 85% of the exposed area on the archipelago. They are mostly mildly alkaline to alkaline and range from gabbros to granites (silica-oversaturated trend) and from alkali gabbros to nepheline syenites (silica-undersaturated trend). Most of the plutonic complexes are younger than 17 Ma and thus post-date emplacement of the flood basalts. However, the Val Gabbro is one of the oldest plutonic complexes on the archipelago (22 Ma: U-Pb apatite) and intrudes the 25 Ma alkaline basaltic pile of the Lower Miocene series (Southeast Province). We are studying the Val Gabbro to better understand the fractionation of the basaltic magmas that formed the lava sequences on the Kerguelen Archipelago.

The 2 km^2 Val Gabbro plutonic complex consists principally of gabbros which is cut by numerous centimeter to meter thick qz-bearing microsyenite sheets. Textural variety in the gabbros is quite large. Coarse-grained clinopyroxene-olivine cumulates (11<MgO<28 wt.%) with interstitial plagioclase or microgabbro contrast with fine-grained plagioclase-rich cumulates (20 wt.% Al_2O_3). The subophitic microgabbros (5 wt.% MgO) represent the parental magma of the cumulates. The geochemistry of the gabbroic rocks is mainly controlled by the relative proportions of interstitial microgabbro (liquid) and either cumulus clinopyroxene-olivine and/or cumulus plagioclase. The subophitic microgabbros show no evidence for silica-enrichment and there exists a major geochemical gap between the gabbros (48-49 wt.% SiO_2) and the microsyenites (57-67 wt.% SiO_2).

There is a strong similarity between major and trace element trends and Sr-Nd-Pb isotope ratios for the subophitic microgabbros of the Val Gabbro and basaltic lavas of the Lower Miocene series suggesting that they are genetically related. The Southeast Province is also characterized by the presence of minor trachytic lavas, tuffs and intrusive plugs which are equivalent in composition to the microsyenites in the Val Gabbro. The microsyenites and trachytic rocks probably result from extensive high-pressure fractionation of mildly alkalic basaltic parent magmas at low magma flux rates.

MS06 : WEpo07 : PO
The Significance of Thick, Aphyric Basaltic Lava Flows on the Kerguelen Archipelago

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Flood basalts on the Kerguelen Archipelago, part of the giant Kerguelen oceanic large igneous province, are predominantly thick, compound, inflated pahoehoe flows. Intriguingly, the majority of these flows are aphyric or contain only a few percent of phenocrysts, despite being mostly low-MgO basalts that should be multi-saturated in plag+cpx±ol±tmt/ilm prior to eruption. Perfect separation of fractionating phases could be called upon for the relatively dense ferromagnesian silicates and Fe-Ti oxides, yet plagioclase densities are nearly identical to the melt densities. Why then do the Kerguelen Archipelago flood basalts commonly contain so few phenocrysts?

Modal estimates from more than 200 flows across the archipelago show that 2/3 of the basalts have less than 5% phenocrysts and fully 1/3 are completely aphyric. Few of the Kerguelen lavas contain more than 10% phenocrysts, and none of them contains more than 20%. The Kerguelen lavas show a bimodal distribution of MgO contents with respect to total phenocrysts. Lavas with more than 8 wt% MgO are ol-phyric, while lavas with less than 7 wt% MgO are predominantly thick, aphyric flows, or contain up to 20% plagioclase phenocrysts in relatively thin flows of alkalic basaltic composition. The Kerguelen lavas also define a limit of crystallinity that decreases with increasing silica, intersecting the silica axis at ~53 wt% SiO_2 - more silica-rich lavas are aphyric. This apparent limit of crystallinity may define a viscosity limit, above which flood basaltic magmas cannot be erupted.

The difference in phenocryst contents in Kerguelen Archipelago basaltic lavas is primarily a function of the PT slope of the liquidus and the relative dissolved water contents in fractionating magmas at depth. New experiments on a mildly alkalic basalt from the 24 Ma Mont Crozier section show that the liquidus is depressed by ~80°C at ~10 kb by the addition of ~1 wt% H_2O. The experiments also show that crystallinity increases linearly with decreasing temperature, which allows crystallinity contours to be calculated from 0-15 kb. Because the slopes of the liquidus and the crystallinity contours are positive in a dry system, rapid ascent of a dry, multi-saturated low-MgO basalt should result in the resorption of all phenocrysts, the eruption of superheated lavas, and the formation of aphyric flood basalts. In contrast, magmas with small amounts of water will be forced to crystallize during ascent. Finally, the presence of the relatively rare, high-MgO ol-phyric basaltic lava flows on the Kerguelen Archipelago is most likely the result of locally enhanced eruptive fluxes.

MS06 : WEpo08 : PO
Experimental Constraints on the Evolution of Mildly Alkaline Basalts from the Kerguelen Archipelago

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Many oceanic islands, such as Hawaii, Iceland and the Galapagos, contain individual volcanoes that have erupted both tholeiitic and alkaline basaltic lavas with similar isotopic compositions. This variation has been related to either differing degrees of partial melting of a common source at different pressures or protracted fractionation of clinopyroxene at high pressure. The 6500 km^2 Kerguelen Archipelago in the Southeast Indian Ocean, part of the giant Kerguelen Large Igneous Province, is formed predominantly of relatively low-MgO, tholeiitic to alkaline basaltic lava flows that were erupted subaerially from ~30 to 24 Ma. The 1000 m-thick 24 Ma Mont Crozier section contains intercalated transitional to alkaline lavas with limited isotopic variation that contain relict, rounded, high-Al clinopyroxene phenocrysts suggestive of an earlier, high-pressure crystallization history.

To evaluate the effect of fractionation on the tholeiitic to alkaline transition in Kerguelen plume-related magmas, we performed 38 experiments from 0-14.3 kb on dried (anhydrous) and undried (water-present) powders of a natural basalt (OB93-147) from Mont Crozier. OB93-147 is a sparsely-phyric basalt (<4% phenocrysts of plag+ol+cpx) with relatively low alkali contents (AI=0.1; Na_2O+K_2O=3.8 wt%) and is one of the most Mg-rich samples (MgO=5 wt%; Mg#=0.45) in the section that shows the appropriate Sr-Nd-Pb-Hf-Re isotopic characteristics of the Kerguelen plume source. The experiments at 0 kb were performed in a Pt-heated furnace (Au-Pd capsules sealed within an evacuated silica-glass tube). All high-pressure experiments were carried out in a 1.27 cm piston-cylinder press (graphite capsules and furnace assemblies in $BaCO_3$ cells). Oxygen fugacities for all runs are estimated to be ~FMQ-1.

Our results demonstrate the important effect of pressure and small amounts of water on stabilizing clinopyroxene as the major liquidus phase in low-MgO basaltic magmas. Plagioclase is the liquidus phase at 0 kb. In the dry system, higher pressure runs at 4.3, 9.3, and 14.3 kb reveal a large stability field of plag+cpx (50:50) from the liquidus up to 50% crystallized at each pressure. This produces a trend of increasing alkalinity, but also decreasing Al_2O_3 with decreasing MgO, opposite to the observed trend for Mont Crozier basalts. In contrast, the hydrous system (~1 wt% H_2O) shows strong liquidus depression and a large stability field of cpx-only. Fractionation of cpx-only at high pressures in the slightly hydrous system produces Al-enrichment in the residual liquids, but only minor changes in alkalinity with significant silica-enrichment. Our study confirms that important increases in alkalinity associated with Kerguelen basalts must reflect primarily lower extents of melting and/or increases in the pressure of melting.

MS06 : WEpo09 : PO
Hf Isotope Systematics of Kerguelen Archipelago and Plateau Lavas: Kerguelen Plume Source Revisited

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To better constrain the Kerguelen Plume source and the nature of components entrained during plume ascent, we analyzed Hf isotopes of Kerguelen Archipelago lavas and basalts from Site 1140 on the northern Kerguelen Plateau and from Site 1137 on Elan Bank. Variations in Hf and Pb isotopes indicate involvement of three components in the genesis of Kerguelen Archipelago and Plateau lavas.

(1) The Kerguelen Plume: Principal component analysis of Hf, Nd and Sr isotopic data for the archipelago lava confirms that 80% of the data set are included within ±1 sigma. This reflects the dominant isotopic signature of the Kerguelen Plume, the main source of Kerguelen basaltic magmatism. The Mt. Crozier basaltic volcano (~24.5 Ma) (with $^{176}Hf/^{177}Hf$) = 0.28281-0.28290, $^{143}Nd/^{144}Nd$ = 0.51254-0.51264 and $^{87}Sr/^{86}Sr$ = 0.70544-0.70510, and the highest $^{206}Pb/^{204}Pb$ (<18.66)) is inferred to have the most representative composition of the Kerguelen Plume source. The ε_{Hf}-ε_{Nd} trend of Mt. Crozier basalts has a shallower slope than the main OIB array, due to more radiogenic Hf isotopic compositions for a given Nd isotopic composition, indicative of a long-term, relatively high Lu-Hf component such as old pelagic sediments. However, the high $^{206}Pb/^{204}Pb$ of Mt. Crozier basalts imply a deep recycling on a relatively short time scale of 1-1.3 Gyr ; the initial Pb isotopic composition of the global subducting sediment composition (GLOSS) ($^{206}Pb/^{204}Pb_i$= 18.001-17.699; $^{207}Pb/^{204}Pb_i$ = 15.607-15.596) should then be only slightly different from Pb composition of Mt. Crozier basalts.

(2) Indian MORB-type component: Amongst all Kerguelen lavas, Site 1140 basalts have the most depleted isotopic compositions ($^{176}Hf/^{177}Hf$ = 0.28304-0.28317; $^{143}Nd/^{144}Nd$ = 0.51253-0.51295; $^{87}Sr/^{86}Sr$ = 0.70428-0.70369) that overlap the composition of Indian MORB. These isotopic signatures are inferred to reflect mixing between the Kerguelen Plume and a depleted MORB-type component that is also present in smaller proportions in a few old archipelago basalts (>28 Ma).

(3) Continental crust component: Site 1137 lavas display low $^{176}Hf/^{177}Hf$ (0.28268-0.28275), $^{143}Nd/^{144}Nd$ (0.51246-0.51256) and $^{208}Pb/^{206}Pb$ (1.097-0.996) that indicate a continental crust contamination. Downhole variations at Site 1137, with an overall decrease in $^{176}Hf/^{177}Hf$ and $^{143}Nd/^{144}Nd$, and increase in $^{207}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ for a relatively low and constant $^{206}Pb/^{204}Pb$, indicate an overall increase of continental contamination with depth.

High-precision Hf and Pb isotopic data for Kerguelen Plateau and Archipelago lavas indicate shallow addition of two components into magmas derived from the Kerguelen Plume: a depleted mantle component that occurs in the 34 Ma Site 1140 basalts and a continental crust component found in the 108 Ma Site 1137 basalts. In addition, isotopic data for Mt. Crozier basalts suggest deep recycling of relatively old pelagic sediments in the plume source. This suggestion supports the hypothesis that mantle plume source includes ancient subducted oceanic crust, as previously suggested for the Hawaiian basalts.

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Thursday AM Session

MS06 : WEpo10 : PO
North Atlantic Volcanic Province – Platinum Group Elements during Magmatic Processes

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The concentrations of the platinum-group elements were determined in mantle-derived volcanic rocks from the seaward-dipping reflector sequence (SDRS) along the southeast Greenland margin in order to determine the geochemical behaviour of these elements during petrogenetic processes.

Major, trace, and rare earth element relations and results of trace element modelling have been taken in consideration to constrain and qualify the behaviour of the PGE during formation and differentiation of mantle-derived melts.

This contribution evaluates the effects of S-saturation and -undersaturation of a magma on the geochemical behaviour of the PGE during magma generation and magma evolution. It is demonstrated that geometrical (shape of the melting regime), chemical (Fe-contents of the melts) and physical factors (degree of partial melting, P/T-variations) have a pronounced effect on the S-saturation of generated melts and therefore on the PGE systematics of magmas.

The fractionation of the PGE during partial melting is inferred to be a consequence of the incompatible behaviour of Pt and Pd in S-undersaturated melts, whereas the behaviour of Ir, Ru, and Rh indicates that these elements are compatible in at least one mantle phase, possibly spinel or PGE alloys. Platinum and Pd behave incompatibly during magma evolution in S-undersaturated magmas. As soon as the magmas reach S-saturation, Pt and Pd behave highly compatibly and becoming effectively depleted in the magmas through partitioning into sulphides which segregated. In contrast, the elements Ir, Ru, and Rh behave compatibly during magma evolution in S-undersaturated as well as in S-saturated magmas. Spinel and Ir-Ru alloys are inferred to be the most likely candidates to be responsible for the compatibility of these elements.

MS06 : THam01 : F6
The Cache Creek Terrane (Canadian Cordillera): Oceanic Remnants of the Permian-Triassic Superplume Event

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Since the Archean, the geodynamic evolution of the Earth has been punctuated by intense plume-related magmatic pulses reflecting periods of anomalous mantle thermal activity. Large volumes of continental flood basalt were emplaced during the Permian-Triassic in China and Siberia presumably following impact of a major mantle plume. However, the presence of oceanic plateaus related to this Permian-Triassic event has never been recorded. The igneous components of the Cache Creek terrane could represent the counterparts of the Chinese and Siberian trapps but emplaced in an oceanic environment. The Cache Creek terrane belongs to an oceanic suture that extends from Yukon to Northern California. This terrane is composed of mafic lavas interlayered with both mid-Permian and Upper Triassic siliceous shales and grewackes and tectonic slices of gabbro, basalt, dolerites and foliated clinopyroxene-rich ultramafic rocks. Locally, the igneous components are in blocks within an argilliceous matrix. The Triassic lavas fall in three rock types. Type 1 is made up of tholeiitic rocks with flat REE patterns and no Nb and Ta enrichments. They are geochemically similar to the mid-Permian volcanics and to oceanic plateau basalts (OPB). Type 2 is distinguished from Type 1 by higher TiO_2 abundances and convex REE patterns. Type 3 is alkalic and has the highest Zr, Nb and Ta contents and the greatest LREE-enrichment. The tectonic slices of intrusive mafic rocks are geochemically similar to N-MORB while the foliated ultramafic rocks are geochemically similar to extremely depleted harzburgites. These cpx-rich ultramafic rocks have very low trace-element contents (less than 0.1 primitive mantle abundances), fractionated REE [$(La/Yb)_N$ = 0.18-1.22], positive Ba, Pb, U and HREE anomalies, and negative Nb-Ta and Zr anomalies. Permian lavas, Triassic Type 1 basalts and the N-MORB affinity intrusive rocks have the highest εNdi ratios (+7.4 to +9.6) and the lowest Pb isotopic ratios. Conversely, alkalic rocks (Type 3) show the lowest εNd_i ratios (+2.0 to +5.3) and the highest Pb ratios. The εNd_i ratios of Type 2 are intermediate those of Type 1 (~+7) and Type 3 (~ +5). This suggests that the mid-Permian volcanics developed in an oceanic island (OIB) environment. The Triassic rocks, on the contrary, originated from a heterogeneous plume source or from the mixing between depleted N-MORB and enriched OIB sources. Thus, the Cache Creek terrane probably represents the preserved parts of a Late Triassic oceanic plateau that collided with the Paleozoic Quesnellia arc and then accreted to the western margin of the North American plate during the Jurassic.

MS06 : THam02 : F6
The Formation of Oceanic Igneous Provinces: The Caribbean Plate

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The thermo-mechanical processes occurring during the formation of oceanic igneous provinces are still poorly constrained. We propose a new model for the genesis of large-scale magmatic provinces applied to the wide igneous plateau of the Caribbean plate, which is based on numerical experiments that account for the elastic-plastic-ductile rheology, lithospheric scale faulting, and thermal properties of the initial lithosphere (including crustal layer) and of mantle plume. The study area is located in the Venezuelan basin in the Caribbean Sea. The Caribbean plate has an abnormally thick crust, composed of formations of different origin. The initial crust (Farallon crust) has been affected by thermal perturbations over the Galapagos hot spot. These perturbations possibly generated crustal thickening with several episodes of volcanism and underplating. Two main plume events have been recorded in the volcanic outflows that are surrounded in the hanging wall by the sedimentary formation and in the foot wall by the initial Farallon crust. The first and major event is dated around 83 Ma, the second one is dated 75 Ma. The underplated material located at Moho level between the upper mantle and the initial crust was seemingly formed during these two phases. Seismic profiles yield interesting images of the smooth and rough reflectors boundary between the oceanic and magmatic plateau crusts. The edge of the igneous province is characterised by a large seaward dipping reflector sequence. This geometry resembles a typical volcanic margin. Our model integrates all data concerning the Galapagos hot spot and the Caribbean plate. We model the ascent of the plume to and through the young hot lithosphere, its evolution and associated crustal deformation, including strain localisations on the edges of the thickening crust. Varying rheological parameters causes different ascent rates of a spherical mantle plume head through the asthenosphere and the lithosphere. The experiments show that the ascent of the plume is followed by its extremely strong flattening when it reaches the lithospheric bottom. At this moment the plume creates large scale extension in the lithospheric layer resulting and deep normal faulting on the edges of the plateau. We reproduced successive stages of the development of the oceanic igneous province.

MS06 : THam03 : F6
The Duration and Timing of the Deccan CFBP

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We report high precision $^{40}Ar/^{39}Ar$ ages of basalt lavas sampled within a well-defined and detailed stratigraphical context in the Deccan CFBP. Data from the stratigraphically highest and lowest basalts are presented, thereby effectively bracketing the lava succession. These data provide the first comprehensive determination for the timing and duration of this important volcanic episode. Analyses were performed using the incremental laser heating technique on plagioclase separates and are reported relative to the GA1550 biotite standard.

Previous dating studies of the Deccan have concentrated upon the 'classic' sections exposed along the Western Ghats escarpment (Courtillot et al., 1986, Duncan & Pyle, 1988). These data provided crucial preliminary insight regarding the timing and duration of the CFBP and appeared to indicate a geologically rapid eruption at, or near to, the K/T boundary (65.0 ±0.1 Ma). The data are widely cited, and have remained pivotal to arguments citing Deccan volcanism as a primary or contributory cause to global floral and faunal extinction. However, whilst 'classic' sections certainly provide easy access to parts of the Deccan succession, they by no means provide a complete chronological record of the eruptions (Mitchell & Widdowson, 1991).

The earliest flows occur in the north-western corner of the main Deccan outcrop where they were erupted directly upon to Late Cretaceous fluvio-marine sediments and dinosaur-bearing Lameta beds (Sahni,1994). Our $^{40}Ar/^{39}Ar$ analyses of these basal lavas yield late Maastrictian ages (e.g. 66.8 ±0.4 Ma), indicating the onset of volcanism some 1.5 - 2 Myr before the K/T boundary. The final Deccan eruptions are preserved in the south-western Deccan (Widdowson & Cox, 1996), and comprise the topmost part of the volumetrically important Wai Subgroup. Widdowson et al., (2000) indicate post K/T ages (e.g. 62.8 ±0.2 Ma) for feeder dykes to this uppermost succession. These young ages are confirmed by the current work which yields similar results (e.g. 63.6 ±0.4 Ma) for lavas from the uppermost Wai Subgroup.

Our data suggest a duration of 2 - 3 Myr for the eruption of the main Deccan basalt lava succession. The onset of volcanism began in the north of the province during the latest Maastrictian, and continued across the K/T boundary into the Danian, with successively younger lavas building on the southern flank of the CFB edifice.

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MS06 : THam04 : F6
Age and Duration of the North Atlantic Igneous Province

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The rapid erosion and subsequent magmatism seen in the North Atlantic during the Tertiary has been linked to the impingement of the ancestral Iceland plume on the base of the lithosphere. The resulting igneous activity is collectively known as the North Atlantic Igneous Province (NAIP), which can be divided into two phases of igneous activity. Phase 1 was mainly widespread continent-based activity occurring in Baffin Island, W and SE Greenland and Britain (61-57 Ma.). Whereas, Phase 2 is associated with the main rifting and break-up event (approximately 56 Ma.), and includes the thick sequences of seaward-dipping reflectors, the Greenland-Faeroes Ridge, and the present day activity in Iceland. The location and duration of the initial phase of magmatic activity is key to an understanding of the influence of the Iceland plume in this region.

The British Tertiary Igneous Province (BTIP) is the easternmost manifestation of igneous activity within the NAIP, and was formed during Phase 1. The BTIP is composed of numerous igneous centres where early plateau lava successions are cross cut by central plutonic complexes and the NW-SE trending dyke swarm. Cross cutting relationships within each igneous centre are well defined, however, the absolute age and duration of the province remains unresolved. Here we present new internally consistent $^{40}Ar/^{39}Ar$ ages that constrain the volcanic activity of the BTIP to less than 2 m.y. and show that the onset of volcanism was contemporaneous throughout the province. These data have important implications for the BTIP and also for the initial location of magmatism in the larger NAIP. In particular, these new data suggest that the plume head impact model is the most appropriate for this large igneous province.

MS06 : THam05 : F6
New Isotopic and Geochronological Constraints on the Origin of an Island Arc Sequence Associated with the Cretaceous Caribbean Oceanic Plateau

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The southern Caribbean represents a complex accretionary margin where island arc-related sequences are found in close association with oceanic plateau fragments and tonalitic batholiths. The arcs, plateaux and related rocks are all apparently of a similar Cretaceous age. Similar island arc sequences are found all around the margins of the Caribbean, but their origins remain enigmatic, particularly given the close temporal and spatial association with the plateau. This study concentrates on the arc-related sequence exposed on the island of Bonaire in the Dutch Antilles (known as the Bonaire Washikemba Formation). We present field, trace element and isotopic data for the volcanics, in order to determine their relationship to the plateau and batholith on the neighbouring island of Aruba.

The volcanics crop out as two separate inliers on Bonaire. The Northern Complex is interpreted as a distal intra-oceanic island arc sequence, and consists of a bimodal association of lavas, mafic and silicic intrusives and volcaniclastics. The Southern Complex is dominated by pillow basalts and silicic volcaniclastic sediments, which are intercalated on a scale of several metres, along with rhyodacite lavas and exogenous rhyodacite domes. These domes are interpreted as parasitic vents, and therefore the Southern Complex represents a more proximal volcanic environment. All evidence suggests that both the Northern and Southern Complexes could represent a continuous magmatic sequence; Ar-Ar studies [in progress, and to be reported] should clarify this.

In terms of trace elements, the volcanic rocks resemble a typical arc sequence, with negative Nb, Ta and Ti anomalies, low Ni and high levels of LILE elements relative to MORB. Most show flat REE patterns, typically enriched to ~30x chondrite, with a slight relative enrichment in light REE. The arc volcanics have trace element patterns distinct from both the plateau and the Aruba batholith. On a plot of Nb/Y against Zr/Y, they plot outside the Iceland neovolcanic array, in contrast with both the Caribbean plateau itself and the Aruba batholith.

New isotope data (Hf, Nd, Sr and Pb) show that the Washikemba Formation partially overlaps the Caribbean oceanic plateau field, and is isotopically distinct from the Aruba batholith. At least two different sources are required to explain the isotope systematics of the Washikemba volcanics. The composition of most of the arc volcanics on Bonaire can be explained through interaction of a normal MORB-type source with a subduction-related component. The Southern Complex rhyodacite domes, however, are geochemically and isotopically distinct, with lower εHf, moderate radiogenic Sr, Nd and Pb, and very low LILE/HFSE ratios, suggesting only a very limited involvement of a slab-derived component.

MS06 : THam06 : F6
The Volcanology and Facies Architecture of Flood Basalts

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In terms of their detailed volcanology and facies architecture, Continental Flood Basalts (CFBs) and associated volcanic rifted margins reveal important information to help our understanding of their evolution. Mafic volcanism, which makes up the majority of preserved material, is characterized by flows 2-3 m to several 10s of meters thick, with ponded flows and occasional massive flow events of the order of 100 m thick. Although most of the flows may be emplaced by the same mechanism as passive inflated sheets, a variety of different facies associations exist dependent on flow volumes and to some extent flow composition. The largest silicic volcanic events are comparable in size to the largest recorded mafic events, however, they are potentially more catastrophic if erupted as ignimbrite flows. Facies, and facies associations identified in CFBs include: Tabular-Classic flows, Compound Flows, Ponded flows, truncation-onlap volcanic disconformities, burial-onlap volcanic disconformities, prograding hyaloclastite facies, preserved shield volcanic features, and sill facies. Many of these features occur on an intermediate to large basin wide scale and may only be revealed by detailed fieldwork, photogrammetry and 3-D geological models.

MS06 : THam09 : F6
Basement Ages from the Southern and Central Kerguelen Plateau: Initial Products of the Kerguelen Large Igneous Province

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Tholeiitic basalt is the dominant rock forming the Cretaceous portions of the Kerguelen Large Igneous Province (LIP). Previous estimates of the volume, age progression, and geochemical characteristics of the basalts are consistent with derivation from a long-lived Kerguelen plume. A major goal of ODP Leg 183 was to quantify the magma output of the plume as a function of time, in order to evaluate specific dynamic models for the formation of the province and to assess compositional and volume flux changes. Here we focus on Ar/Ar step-heating experiments on the initial products of the province, the Southern and Central Kerguelen Plateau and Broken Ridge.

The oldest ages (c. 118 Ma) are from plagioclase from Site 1136 on the southeastern margin of the Southern Kerguelen Plateau and from the then-nearby Rajmahal basalts on the Indian continental margin. Whole rock plateau ages from both areas appear slightly younger (113-115 Ma), perhaps due to small amounts of alteration combined with minor Ar-recoil in the whole rock experiments. Plagioclase from ODP Site 750 on the northeastern margin of the Southern Kerguelen Plateau is slightly younger (112 Ma). Elan Bank, a western prominence between the northern and central portions of the Plateau, is 109-110 Ma, as determined on both whole-rock basalt and plagioclase separated from those basalts.

Previously, it was thought that the Central Kerguelen Plateau was 85-90 Ma, based on poorly-constrained biostratigraphy and 2 discordant Ar/Ar plateaus from a leached, altered groundmass separated from an ODP Site 747 basalt. Similarly, dredged basalts from the then-adjacent Broken Ridge were thought to be 83-88 Ma. In fact, the existence of these ages, c. 30 m.y. after initial signs of magmatism, was an important observation used to invoke the double plume model. However, ages of 94 Ma for Sites 1141/42 on Broken Ridge, and especially 103 Ma for Site 1138 in the Central Kerguelen Plateau, show that central Plateau magmatism follows the formation of the Southern Plateau by significantly less than 20 m.y.

Thus, for initial products of the Kerguelen LIP, (1) the double plume head model based on a bimodal age distribution is now untenable, (2) an impact plume model describing voluminous volcanism over significantly less than 5 m.y. is not necessary, (3) an incubating plume model describing rifting and initiation of magmatism over c. 10 m.y. is plausible, and (4) even a volcanic passive margin model, with a relatively continuous magmatic flux over c. 20 m.y., cannot be ruled out.

MS06 : THam10 : F6
Involvement of Continental Crust in Formation of the Kerguelen Plateau: New Trace Element and Sr-Nd-Pb Data for ODP Leg 120 Basalts (Sites 747, 749 and 750)

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Ocean Drilling Program (ODP) Leg 183 established that fragments of continental crust occur in the oceanic lithosphere of Elan Bank, a domain of the Kerguelen Plateau (Frey et al., 2000). Important questions for Kerguelen Plateau magmatism are the relative contribution of continental crust to mantle-derived magmas, and the area extent of continental crust fragments. The altered tholeiitic basalts from ODP Leg 119 (Site 738) and ODP Leg 120 (Sites 747, 749 and 750) are important in answering these questions. In order to evaluate the contribution of continental crust to these basalts, we use correlations among abundance ratios of incompatible elements and isotopic ratios of Sr, Nd and Pb. Although the new isotopic data confirm the isotopic differences between the Leg 120 drillsites, we find that previously published data for samples powdered on the ship (Salters et al., 1992) were affected by Pb contamination.

In contrast to lavas from Site 738 on the southern Kerguelen Plateau (SKP) (Mahoney et al., 1995; Borisova et al., 2001), there is no geochemical evidence for contamination by continental crust in basalts from Sites 749 and 750 on the SKP. Lavas from Sites 749 and 750 overlap in age-corrected $(^{143}Nd/^{144}Nd)_i$ (0.51262-0.51279). Site 749 lavas have low $(^{87}Sr/^{86}Sr)_i$ (0.70352-0.70413) and high $^{206}Pb/^{204}Pb$ =17.990-18.035, $^{207}Pb/^{204}Pb$ =15.506-15.577 and $^{208}Pb/^{204}Pb$ =37.85-38.15, whereas Site 750 basalts have higher $(^{87}Sr/^{86}Sr)_i$ (0.70496-0.70535) and unradiogenic $^{206}Pb/^{204}Pb$ =17.474-17.551, $^{207}Pb/^{204}Pb$ =15.404-15.486 and $^{208}Pb/^{204}Pb$ =37.67-38.05. Basalts from these sites are moderately enriched in LREE ($(La/Sm)_n$= 0.9-1.3). Their $(La/Nb)_n$ (0.9-1.2), $(La/Ta)_n$ (0.6-1.4) and $(La/Th)_n$ (0.6-1.5) overlap with those of Southeast Indian Ridge MORB (Dosso et al., 1988).

In contrast, Site 747 basalts from the central Kerguelen Plateau have unradiogenic Nd and Pb isotopic compositions ($(^{143}Nd/^{144}Nd)_i$=0.51233-0.51242 and $^{206}Pb/^{204}Pb$ = 17.360-17.709, $^{207}Pb/^{204}Pb$ =15.388-15.523, $^{208}Pb/^{204}Pb$ =37.72-38.13 and moderate $(^{87}Sr/^{86}Sr)_i$=0.70549-0.70569. They have the highest LREE enrichment $(La/Sm)_n$ =1.9-2.5 amongst Leg 120 basement tholeiites, and are depleted in Nb-Ta with $(La/Ta)_n$ up to and $(La/Nb)_n$ up to 2.01 and 1.72, respectively. Site 747 basalts have moderate $(Th/Ta)_n$=0.9-1.5 and their variable Th depletion is indicated by high $(La/Th)_n$=1.2-1.8. The trace element and Sr-Nd-Pb isotope features which are similar to those of the olivine-phyric basalts from the Aphanasey Nikitin Rise (Borisova et al., 2001), indicate that the Site 747 basalt suite was contaminated by the lower continental crust. Unradiogenic Nd and Pb isotopic compositions, Nb-Ta depletion and variable Th contents of basalts from Sites 747 and 738 suggest involvement of ancient continental crust characterized by low time-integrated Sm/Nd, variable U/Pb and Th/U and relative depletion in Nb and Ta. In addition to the evidence of *in situ* continental crust in the Elan Bank basement (Frey et al., 2000), the data support the localized presence of ancient continental crust during the formation of the central and southern domains of the Kerguelen Plateau. However, there are significant isotopic differences, especially in Pb, between the continental components that contributed to the Kerguelen Plateau basalts at these three sites. Given the heterogeneity of continental crust and the size of the Kerguelen Plateau this result is not surprising.

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MS06 : THam11 : F6
Age and Provenance of Conglomerate Clasts Recovered from Elan Bank, Kerguelen Plateau, Southern Indian Ocean

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At Elan Bank of the Kerguelen Plateau in the southeast Indian Ocean, ODP Leg 183 recovered rounded metamorphic and igneous clasts in a 26-m-thick fluvial conglomerate and a 15-m-thick crystal-vitric tuff found within the c. 150-m-thick basaltic basement section.

All the dated igneous clasts are contemporaneous with the Cretaceous basaltic volcanism that constructed the plateau. Single crystal Ar/Ar step-heating on biotite separated from one granitoid pebble revealed an age of 112 ±1 Ma. Single-crystal Ar/Ar step-heating analyses of sanidine separated from several flow-banded rhyolites, feldspar-pyroxene-phyric trachytes, and the crystal-vitric tuff itself average 109.3 ±0.1 Ma. However, although relatively fresh in thin section, all sanidine age spectra show subtle but significant volume diffusion and/or alteration-related profiles. The crystallization ages reported here average only the highest temperature plateau steps, representing 16 to 91 percent of the gas released from individual sanidines (n=23). Further optical, cathodoluminescence, and SEM examination has shown that showed that the feldspars are surprisingly complex. Most exhibit a number of features that may be responsible for the low apparent ages in the age spectra, especially partially healed fractures distinguished by trails of micropores and albite exsolution lamellae up to several hundred microns long by c. 1 micron wide. Further detailed mineralogical studies of these feldspars will be presented, with the particular goal of developing criteria for selecting which sanidine populations are most appropriate for Ar/Ar versus U/Pb intercalibration studies.

All the dated metamorphic clasts (principally garnet-biotite gneiss and schist) are Proterozoic in age. Single-crystal biotite Ar/Ar and zircon and monazite U/Pb dates from the clasts and an overlying sandstone range from 530 to 2550 Ma. This significantly older than the volcanic rocks intercalated with the sediments as well as the Indian Ocean seafloor surrounding the Plateau. However, similarly-aged material is found in the high-grade metamorphic rocks of the Eastern Ghats and Chotonagpur gneiss of India, in the Prydz Bay area of eastern Antarctica, and among the paragneisses and plutonic rocks of Western Australia. These old dates show that old continental material resides in the shallow crust of the oceanic Kerguelen Plateau, and we conclude that the breakup of Gondwana dispersed continental fragments into the nascent Indian Ocean lithosphere.

MS06 : THam12 : F6
The Incipient Kerguelen Large Igneous Province: Evidence from Elan Bank, ODP Leg 183, Site 1137

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Flood basalt volcanism typifies many rifted continental margins, but their connection to mantle plumes remains unclear. The Bunbury Province in Western Australia (130-123 Ma) and the Rajmahal Traps in northeastern India (116-113 Ma) are temporally associated with rifting among Australia, Greater India, Antarctica and one or more microcontinents and have been linked to the initial lithospheric impingement of the Kerguelen Plume. The Kerguelen Large Igneous Province began to form around this time, ~119 Ma (Pringle and Duncan, 2000). Elan Bank, a western salient of the Kerguelen Plateau, is capped by a sequence of subaerial basalts and volcaniclastic sediments erupted during early plateau construction (~109 Ma; Duncan and Pringle, 2000); it may therefore have implications for the initial tectonic setting of the Kerguelen Plume and its role in the break-up of Eastern Gondwana. Geochemical characteristics of Elan Bank basalts suggest they may be a submerged, tholeiitic, continental flood basalt sequence related to the Rajmahal Traps. Elements sensitive to crustal contamination and Sr, Nd, Pb and Hf isotopes reflect variable assimilation of continental crust by plume-derived source magmas (e.g. Nb/La <1; initial ε_{Nd} = 0 to -3). Sr-Nd isotopes of Elan Bank basalts, together with Rajmahal Group 2 lavas (extending to higher $^{87}Sr/^{86}Sr$ and lower $^{143}Nd/^{144}Nd$), bridge the gap between the majority of rocks on the Kerguelen Plateau and Archipelago and the most contaminated basalts, at Site 738 (southernmost Kerguelen Plateau). In a plot of $^{207}Pb/^{204}Pb$ or $^{208}Pb/^{204}Pb$ versus $^{206}Pb/^{204}Pb$, Elan Bank basalts and Rajmahal Group 2 overlap and create a vertical trend that requires a different crustal contaminant than that of Site 738. Felsic volcanic rocks and clasts in the Elan Bank sequence have extremely enriched isotopic values similar to juvenile Proterozoic crust with initial ε_{Nd} ranging from -5 to -6.5; yet a Rb-Sr isochron gives an age of ~110 Ma, indicating contemporaneous felsic and basaltic volcanism. Rare gneiss clasts have initial ε_{Nd} = -14 and more extreme $^{208}Pb/^{204}Pb$ (~40.4) than the felsic volcanic rocks (~39.8). Wide-angle seismic data show a low velocity zone suggestive of continental rock in the lower crust of Elan Bank (Charvis et al., 1997). Elan Bank basalts have geochemical and isotopic data consistent with eruption through continental crust. Elan Bank is distinguished by bimodal volcanism (a feature of some rifted margins), felsic volcanic rocks of continental derivation, continental crust fragments of garnet-biotite gneiss, and generally comparable geochemistry and isotopic ratios to lavas of the Rajmahal Traps. These characteristics imply that the ~109 Ma Elan Bank sequence may have formed on a rifted fragment of India and provide new insights into the relationship between the Kerguelen Plume and the break-up of Eastern Gondwana.

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MS06 : THam13 : F6
A Petrological and Geochemical Study of Mafic and Felsic Volcanic Rocks from Skiff Bank, Site 1139, ODP Leg 183, Kerguelen Plateau

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A 230-m thick bimodal volcanic sequence was drilled at Site 1139 of ODP Leg 183, on Skiff Bank, a western salient of the Kerguelen plateau. The sequence has been dated at 68 Ma (R. Duncan & M. Pringle, 1999) and is significantly younger than other parts of the Central Kerguelen plateau (80-90 Ma). The sequence comprises three main units: an uppermost sequence of dominantly rhyolite flows and probably subaerial felsic pyroclastics, a central sequence of trachybasaltic flows, and a lower sequence of trachytic lavas. The trachybasalts are alkalic and show marked enrichment in incompatible trace elements. They resemble rocks from younger shield volcanoes of the Kerguelen Archipelago. In contrast, the felsic rocks have relatively high SiO_2 and low alkalis, features that indicate tholeiitic affinity.

The rocks show a very large variation in calculated $(^{87}Sr/^{86}Sr)_i$, from 0.7054 to an extreme value of 1.496. The trachybasalts have relatively constant and low values close to 0.7056. The highest Sr ratios were measured in highly altered felsic rocks. Leaching of these (15 min in 6N HCl in ultrasonic bath) removed 8-20% of the Rb and about 90% of the Sr. The leached samples have Rb and Sr contents similar to those of less altered samples, which have more normal $(^{87}Sr/^{86}Sr)_i$. This suggests that the high ratios may have resulted from a recent alteration event that added more Sr and than Rb and strongly decreased the Rb/Sr of the samples. The measured Nd isotope composition is very uniform ($^{143}Nd/^{144}Nd$ = 0.5124 to 0.5128, εNd = 0 to -2) with two outliers at εNd = 3.1 and -4.4. Lead isotope ratios are low and relatively uniform ($^{206}Pb/^{204}Pb$ 17.49 to 17.89; $^{207}Pb/^{204}Pb$ 15.48 to 15.53; $^{208}Pb/^{204}Pb$ 37.97 to 38.58).

Despite the presence of the evolved rocks, Skiff Bank is characterized by isotopic compositions comparable to basalts from Sites 747 and 750 in the older central portion of the Kerguelen Plateau. The combination of slightly negative εNd with low isotopic ratios of Pb and Sr (except for the altered samples) suggests the involvement of material with composition like that of old lower continental crust. The presence of this material on Skiff Bank increases, in time and in space, the known extent of old continental lithosphere throughout the Indian ocean basin. The sequence probably forms part of a shield volcano that formed at least 10 m.y. after the peak of plateau volcanism in the Central Kerguelen Plateau.

MS06 : THam14 : F6
Age, Composition, and Eruptive Environment of the Ontong Java Plateau, Western Pacific Ocean: Initial Results of Ocean Drilling Program Leg 192

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Ocean Drilling Program (ODP) Leg 192 recently drilled and cored five sites (1183-1187) on the Ontong Java Plateau. The leg?s primary objectives were to determine (1) the age and duration of emplacement of the plateau, (2) the compositional range of magmatism, and (3) the environ-

ment and style of eruption. Acoustic basement at four sites consists of pillow and/or massive basalt flows with rare, thin sedimentary interbeds. Biostratigraphic evidence indicates Aptian basement ages at Sites 1183, 1186, and 1187. At Site 1185, a lower basalt group is Aptian, and an upper basalt group is estimated to be latest Cenomanian to Albian. These results, combined with data from Deep Sea Drilling Project Site 289 and ODP Site 807, suggest that most of the main plateau formed in a single episode in early Aptian time. Later volcanic events, including the ~90 Ma event recorded at Site 803 and in the eastern Solomon Islands, appear to have been volumetrically minor on the main plateau and largely confined to its margins. A late-stage event is recorded at the fifth site, Site 1184, on the plateau's eastern salient, where we cored 338 m of middle Eocene basaltic volcaniclastic rocks. Basalt at Sites 1183 and 1186, and the lower group of lavas at Site 1185, are similar in composition, and belong to the homogeneous Kwaimbaita magma type found at Site 807 and in the eastern Solomons. Thus, much of the high plateau's upper crust appears to consist of Kwaimbaita-type basalt. Eocene volcaniclastic rocks of Site 1184 also have a Kwaimbaita-like bulk composition. No flows of Singgalo-type basalt, which overlies Kwaimbaita-type lavas at Site 807 and on the island of Malaita, were encountered. Basement at Site 1187 and the upper flows at Site 1185 are composed of high-MgO (8-10 wt%), incompatible-element-poor (e.g., TiO_2 = 0.72-0.77 wt%; Zr = 36-43 ppm) basalt not found previously on the plateau. These rocks appear to represent large degrees of partial melting of their mantle source, and their presence in >100-m-thick lava piles at two sites 146 km apart suggests that such basalt is voluminous on the eastern edge of the main plateau. Emplacement of lavas at the four sites on the main plateau was entirely submarine. The shallowest estimated Aptian water depth for basement is several hundred meters, at Site 1183 on the broad dome of the plateau. Together with previous evidence, our results indicate that much of the Ontong Java Plateau formed below sea level. The only evidence that a portion of the high plateau was ever at shallow depth is in two thin intervals of Aptian vitric tuff above basement at Site 1183, and possibly a vitric tuff just above basement at Site 289.