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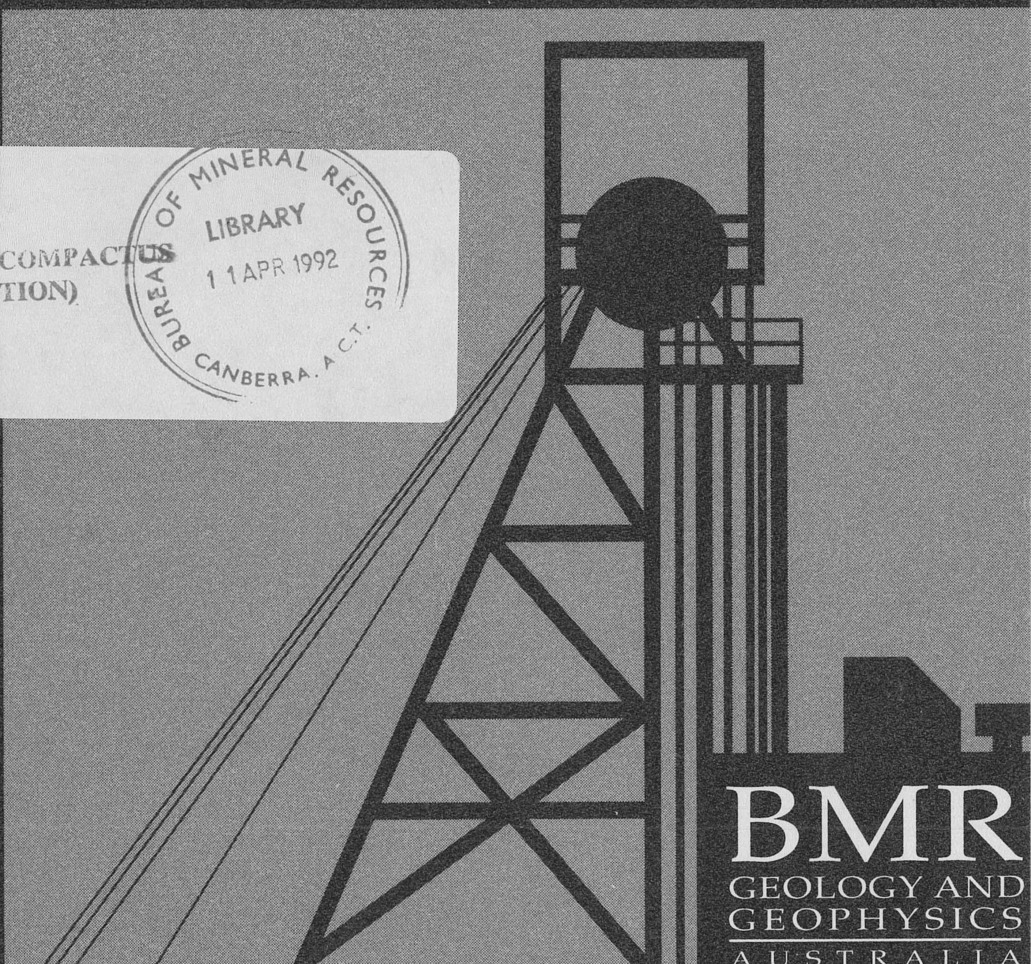

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David A. Wallace

MINERALS AND LAND USE PROGRAM
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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Andover Mafic–ultramafic Complex, West Pilbara, Western Australia: Chemical and Petrographic Data, and Summary of Geology. Record 1992/13.

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DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

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INTRODUCTION

Following a review of layered mafic-ultramafic intrusive complexes in the Halls Creek Mobile Zone and the Pilbara Block, Western Australia (Hoatson, 1984), a BMR field programme was carried out on a group of layered mafic-ultramafic intrusives in the West Pilbara (Fig. 1). The programme was undertaken with the objective of developing a greater understanding of controls on ores of orthomagmatic origin (platinum group elements (PGE), Cr, V, Ni) in the West Pilbara layered mafic-ultramafic intrusions.

The West Pilbara group of layered peridotite-pyroxenite-gabbro intrusives lie in an east-northeast-trending zone, 120 km long and 35 km wide, stretching from the Munni Munni Complex in the southwest to the Balla Balla intrusion, 65 km east of Roebourne. This report summarizes the geology, and presents geochemical and petrographic data on one of the largest of these bodies, the Andover (Mount Hall-Carlow Castle) Ultramafic Complex (Fig. 2). Studies of other layered complexes in the group are documented elsewhere (Hoatson, 1991a; Hoatson & England, 1986; Hoatson & Keays, 1989, Sun & others, 1990; Wallace & Hoatson, 1990). A detailed report of the geochemistry and platinum-group element geochemistry of the Andover Ultramafic Complex (AUC) is included in a forthcoming BMR report on the West Pilbara layered intrusives (Wallace, in prep).

Over two hundred surface samples were collected for chemical analysis from within the AUC. Representative rocks were systematically collected along several semi-detailed traverses through selected areas. These traverses were aimed at establishing and identifying the broad lithostratigraphy of the ultramafic and gabbroic rocks making up the layered sequence (Table 1).

Rock nomenclature follows the scheme for mafic and ultramafic intrusive rocks proposed by Streckeisen (1973, 1976), based on modal proportions of olivine, clinopyroxene, orthopyroxene and plagioclase. Geographical coordinates of sample locations are listed in Appendix 1. Chemical analyses are listed in Table 2, and details of analytical methods used are given in Appendix 2.

GEOLOGICAL SETTING AND STRUCTURE

The Andover Ultramafic Complex is located 3 km south of Roebourne at latitude 20°50'S and longitude 117°10'E on the 1 : 100 000 Roebourne 2356 Topographic Sheet and 1:250 000 Roebourne SF/50-3 Geological Sheet (Ryan, 1966). It covers an area of 7 by 20 km.

The AUC displays some geological features similar to other Pilbara intrusions and to major overseas PGE-hosting stratiform complexes, such as the Bushveld Complex (South Africa), and Stillwater Complex (USA). Because of these similarities, and particularly in light of the promising exploration results from the nearby Munni Munni Complex, exploration interest has recently focussed on the Cu and Ni and precious metal (PGEs and Au) potential of the AUC.

The AUC is interpreted as a trough-shaped lopolith, having an east-northeasterly elongation. The intrusion is tilted at an angle of about 10° to the southwest, but locally steeper attitudes are attributed to faulting. The lowermost units crop out on the northern and eastern parts of the complex and the uppermost units are exposed in the southwestern part.

STRATIGRAPHY

The AUC comprises a lower ultramafic zone and an overlying gabbroic zone, made up of a differentiated ultramafic-mafic layered series of rocks (Table 1). The general cyclic pattern, crystallisation order and mineralogy of the ultramafic layered sequence are similar in some respects to that documented for other layered intrusions such as the Bushveld and Stillwater complexes.

The complex has a minimum estimated thickness of 2.1 km. The shallow-dipping nature of the layered sequence, combined with its subdued topographic expression, intense faulting and alteration, makes it difficult to distinguish and laterally correlate the various lithological units of the AUC over any appreciable distance. For this reason it is not possible to subdivide the complex with the same degree of confidence and accuracy as has been done for the more steeply-dipping terrain of the Munni Munni Complex (Hoatson & Keays, 1989; Hoatson, 1991b).

Because of the shallow-dipping layering it is difficult to estimate how much of the AUC exists as a 'hidden zone' beneath the exposed surficial part. Unpublished aeromagnetic data by Greater Pacific Resources, however, suggests that there are unlikely to be any major lateral sub-surface extensions of the AUC.

The **ultramafic zone** consists of an estimated 1300 m-thick series of rhythmically layered horizons which comprise some, or all, of peridotite, lherzolite, olivine websterite, clinopyroxenite, olivine orthopyroxenite, orthopyroxenite, clinopyroxenite, and websterite, together with interlayered anorthosite, anorthositic gabbro, and gabbro horizons. On the basis of geochemical profiling of peridotites through the ultramafic zone, it was possible to subdivide the ultramafic zone into seven subzones. These subzones, designated A to G, are overlain by the gabbroic zone. Within these subzones, cyclic units ranging from several centimetres to several metres in thickness, can be recognised in places.

The subzones represent a series of cyclic sequences comprising harzburgite ± lherzolite, pyroxenite (± orthopyroxenite ± websterite ± clinoproxenite), anorthositic gabbro/anorthosite ± gabbro. Cumulus mineral trends follow a crystallisation order characterised by olivine + chromite, olivine + orthopyroxene + chromite, orthopyroxene ± chromite, orthopyroxene ± clinopyroxene, and plagioclase + clinopyroxene.

The **gabbroic zone**, with an estimated thickness of at least 800 m, is defined by the first appearance of cumulus plagioclase, and consists of a mixed series of massive, undifferentiated gabbro, anorthositic gabbro, and anorthosite. The gabbroic zone is exposed over an extensive area in the western sector of the AUC, but was not examined in sufficient detail to establish any characteristics permitting subdivision. It is probable that the original thickness of the gabbroic zone greatly exceeded this estimate and has been lost through erosion. However, because of the sub-horizontal attitude of the intrusion this is difficult to assess.

PETROGRAPHY

Rocks are mostly hydrated to some extent and many are also oxidised. Most rocks have undergone some form of alteration due to low-grade greenschist facies metamorphism, characterised by chlorite, talc, sericite, epidote, and tremolite-actinolite products.

Processes such as hydration, carbonation, silicification, and recrystallisation have selectively affected some rock types more than others.

Peridotite

Peridotites are completely serpentinised cumulates, originally consisting of olivine and orthopyroxene. Textures are well preserved, despite the extensive hydration which they have undergone and the major minerals are usually preserved as identifiable pseudomorphs. Olivine is present as granular cumulus grains amounting up to 70 percent of the rock. Pseudomorphed orthopyroxene is predominantly an intercumulus phase, which is commonly poikilitic. Clinopyroxene, where present, occurs only interstitially in trace amounts. Modally and normatively these rocks can be classed as harzburgites. Finely disseminated chromite grains are present in most peridotites.

Lherzolites are also extensively hydrated rocks, differing compositionally from the harzburgites by lower modal olivine and the presence of 10 vol. % or more of clinopyroxene. Rare relict areas of unaltered clinopyroxene may be preserved in some lherzolites. Sample #92 contains finely disseminated chromite.

Pyroxenite

With relatively few exceptions pyroxenites are orthopyroxene-dominant cumulates, continuing the orthopyroxene-dominant character shown by earlier-crystallising harzburgites. Of six rocks classified as clinopyroxenites, three contain significant intercumulus orthopyroxene (up to 10 vol. %), including pleochroic hypersthene. Olivine-free pyroxenites, notably orthopyroxenites and websterites with high proportions of orthopyroxene, are generally the least altered rock types. Of these, orthopyroxenites tend to be particularly well preserved, with some samples, e.g., #43, showing only minimal alteration along margins of cumulus orthopyroxene. Orthopyroxene tends to become altered to talc and clinopyroxene is more commonly uralitised, with common retrogressive alteration of this amphibole to chlorite. Olivine-bearing pyroxenites (olivine orthopyroxenite, olivine websterite) on the other hand, are rarely unaltered, owing to the relatively greater susceptibility of olivine to hydration, resulting in greater penetration of the rock fabric.

Exsolution textures in clinopyroxene are either absent or poorly developed. In contrast typical 'Bushveld type' exsolution in orthopyroxene, characterised by well-developed, thin, daughter lamellae of exsolved diopsidic augite in the (100) plane, is ubiquitous in most ultramafic cumulates.

Plagioclase is present in all pyroxenites as a minor intercumulus phase, but is only rarely unaltered; microprobe analyses of relict plagioclase show consistent bytownite compositions. Minor interstitial quartz and traces of biotite are present in some websterites, e.g., sample #204. Olivine orthopyroxenite and orthopyroxenite commonly contain finely disseminated chromite (up to 1 percent Cr in sample #18).

Gabbro, anorthositic gabbro, and anorthosite

These rocks are invariably completely saussuritised. Ferromagnesian minerals are commonly uralitised and amphibole is commonly altered to chlorite. Traces of micrographically intergrown plagioclase and quartz are rarely visible, as are pseudomorphs after glomeroporphyritic pyroxene. In contrast norites are commonly relatively fresh, two-pyroxene (hypersthene and salite) rocks, in which feldspar (bytownite) is partially preserved.

Aplite

Aplite (sample #168) pervasively intrudes the southern part of the AUC along a broad east-west 'corridor'. Aplites are microcline + mica + quartz rocks which crop out over short distances along this corridor, east of the Harding River, as massive tabular bodies several metres in thickness. West of the river the corridor narrows, extending almost up to the ultramafic zone-gabbroic zone contact, as several narrow dykes. Contacts with the ultramafic rocks are usually bounded by thin mica (lepidolite) schists, enriched in Rb and Li (samples #172, 184). Aplites also coincide with areas of pervasive asbestos serpentinisation.

COUNTRY ROCKS

Rocks of the Roebourne Syncline sequence are exposed in the Mount Hall area on the northern margin of the AUC and west of the Andover lead mine on the southern margin. In the Mount Hall area the AUC cross-cuts a sequence consisting of interbedded volcanic and sedimentary units and amphibolite. The amphibolite (samples #115, 178, 183) occurs immediately adjacent to the AUC as a narrow contact aureole which, going away from the ultramafic complex gives way to a sequence of interbedded schistose rocks, ferruginous and silicified metasediments, thin chert, and spinifex-textured komatiitic lavas.

The komatiites (sample #114) are tremolite-chlorite-antigorite rocks, in which spinifex textures are well preserved in places. The komatiites have an Al-depleted character (Al_2O_3/TiO_2 =13), which is quite different from the Al-normal komatiites (Al_2O_3/TiO_2 = 27-30) of the 3.5 Ga Warrawoona volcanics. The Al- depleted character of the komatiites, together with their spinifex texture and associated metasedimentary horizons, are features similar to the Ruth Well sequence (Nisbet & Chinner, 1981; Sieber & others, 1990). On this basis the Mount Hall sequence is regarded as an easterly outlier of the Ruth Well geosynclinal sequence.

Low-lying rubbly Roebourne Syncline rocks also crop out along part of the southwestern margin of the AUC. These were only briefly examined and have been described by Archer (1979) as consisting predominantly of altered basalts (sample 121), some spilitic, together with intermediate volcanics and minor dolomitic horizons.

Tonalite (sample #117) crops out sparsely along the northern margin of the AUC, west of Mount Hall. Tonalite (samples #95, 98), granodiorite, and leucocratic granite also crop out along the southern boundary of the AUC and extend southwards to the Sholl Shear Zone.

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Figure Captions

Fig.1. West Pilbara mafic-ultramafic rock units

Fig.2. Andover Complex - geology, mineral occurrences, old mineral workings. Sample traverses are indicated by broken line. Locations of subzones in the ultramafic zone shown as **A -G**

Appendix 1: Location of samples from the Andover Complex

Sample	Gridref	Lat (S)	Long (E)	Sample	Gridref	Lat (S)	Long (E)
86330001	197013	20.787848	117.190105	86330055	167000	20.800113	117.160291
86330002	076970	20.826999	117.072976	86330056	167000	20.799516	117.160271
86330003	065946	20.848463	117.062672	86330057	166002	20.798378	117.159953
86330004	076970	20.827026	117.072956	86330058	149983	20.814667	117.142854
86330005	065946	20.848445	117.062691	86330059	149983	20.815290	117.143172
86330006	078941	20.852832	117.074545	86330060	149983	20.815281	117.143191
86330007	078941	20.852832	117.074545	86330061	149982	20.815569	117.143634
86330008	079952	20.843307	117.076376	86330062	148970	20.826874	117.142357
86330009	093939	20.854785	117.089513	86330063	148969	20.827462	117.142165
86330010	092940	20.854054	117.088898	86330064	149972	20.825401	117.143230
86330011	091941	20.853467	117.087753	86330065	144978	20.819541	117.138361
86330012	090941	20.853296	117.086705	86330066	144977	20.820336	117.138314
86330013	090941	20.853016	117.086138	86330067	144975	20.822550	117.138201
86330014	090942	20.852501	117.086230	86330068	129966	20.830133	117.123618
86330015	090942	20.852031	117.086291	86330069	128965	20.831462	117.122735
86330016	093943	20.851253	117.089357	86330070	130972	20.825388	117.124940
86330017	093943	20.851253	117.089367	86330071	119971	20.825856	117.114369
86330018	089943	20.851616	117.085734	86330072	119970	20.826534	117.114763
86330019	090943	20.850992	117.086714	86330073	121971	20.825701	117.166301
86330020	089945	20.849483	117.085550	86330074	121970	20.826659	117.116436
86330021	090956	20.839299	117.086918	86330075	235958	20.837718	117.225958
86330022	087959	20.836970	117.083986	86330076	235959	20.836372	117.225764
86330023	092954	20.841404	117.087996	86330077	233959	20.836510	117.223621
86330024	144995	20.804360	117.138290	86330078	233961	20.834947	117.223859
86330025	144994	20.805002	117.138281	86330079	236968	20.828221	117.226338
86330026	143990	20.809123	117.137583	86330080	199956	20.839856	117.191532
86330027	144993	20.805905	117.138426	86330081	199957	20.838266	117.190963
86330028	144990	20.809204	117.138390	86330082	198958	20.837210	117.190481
86330029	143989	20.809945	117.137219	86330083	201963	20.833149	117.193648
86330030	143988	20.810650	117.137171	86330084	171971	20.826141	117.164211
86330031	143982	20.815846	117.137618	86330085	189966	20.830451	117.182054
86330032	142981	20.817301	117.136802	86330086	188968	20.828790	117.180889
86330033	175983	20.814716	117.168254	86330087	188970	20.826576	117.181069
86330034	202973	20.823715	117.194126	86330088	186973	20.824337	117.178884
86330035	179975	20.822455	117.172414	86330089	183973	20.823780	117.176183
86330036	177976	20.821057	117.170260	86330090	144975	20.822107	117.137922
86330037	176978	20.819955	117.169480	86330091	177969	20.827291	117.170344
86330038	176979	20.818700	117.169258	86330092	143987	20.811527	117.137000
86330039	175980	20.817752	117.168219	86330019	090943	20.850992	117.086714
86330040	175980	20.817887	117.168200	86330094	066977	20.820868	117.063502
86330041	174982	20.815720	117.166737	86330095	066977	20.820859	117.063516
86330042	174982	20.815783	117.166852	86330096	078976	20.821911	117.074857
86330043	174984	20.814410	117.167043	86330097	080942	20.852578	117.076775
86330044	174984	20.814220	117.166783	86330098	074941	20.853150	117.071162
86330045	176984	20.814003	117.167167	86330099	065966	20.830762	117.062309
86330046	174986	20.812386	117.167060	86330100	151982	20.816300	117.144903
86330047	165991	20.807641	117.158963	86330101	150981	20.816952	117.144077
86330048	167993	20.805931	117.160710	86330102	150980	20.817900	117.143972
86330049	167995	20.803989	117.160574	86330103	149979	20.818624	117.143348
86330050	168996	20.803003	117.161437	86330104	149979	20.819085	117.143099
86330051	166997	20.802417	117.159947	86330105	149978	20.819898	117.142715
86330052	166997	20.802453	117.159938	86330106	150977	20.820882	117.143975
86330053	166998	20.801486	117.159898	86330107	150976	20.821081	117.144379
86330054	166999	20.800746	117.159782	86330108	152974	20.823293	117.145630

APPENDIX 1 (continued)

Sample	Gridref	Lat (S)	Long (E)	Sample	Gridref	Lat (S)	Long (E)
86330109	160983	20.815425	117.153993	87330163	145971	20.825973	117.139213
86330110	160983	20.815425	117.154003	87330164	139954	20.840996	117.133181
86330111	160983	20.815425	117.154003	87330165	142958	20.837731	117.136744
86330112	160983	20.815425	117.154003	87330166	142957	20.838237	117.136341
86330113	154978	20.819772	117.148414	87330167	142971	20.825641	117.136329
86330114	197013	20.787848	117.189622	88330168	152995	20.803902	117.145708
86330115	198011	20.789573	117.190105	88330170	218965	20.830889	117.209561
86330116	198010	20.791028	117.190106	88330171	218965	20.831558	117.209543
86330117	198011	20.790080	117.189990	88330172	521643	20.834542	117.208019
86330118	209002	20.797938	117.200723	88330173	164997	20.802808	117.157219
86330119	209002	20.797938	117.200733	88330174	164997	20.802799	117.157219
86330120	209002	20.797938	117.200733	88330175	169001	20.799134	117.162807
86330121	106932	20.861320	117.102117	88330176	179009	20.791210	117.171841
87330124	176979	20.818709	117.169248	88330177	180011	20.789998	117.172858
87330125	102948	20.846422	117.098332	88330178	180011	20.789989	117.172867
87330126	105951	20.844144	117.101214	88330179	205003	20.797047	117.197330
87330127	108953	20.842480	117.103828	88330180	205002	20.797590	117.196860
87330128	113954	20.841745	117.108796	88330181	204002	20.798313	117.196217
87330129	120957	20.838569	117.114946	88330182	203001	20.798622	117.195228
87330130	119957	20.838931	117.114321	88330183	207013	20.788326	117.198693
87330131	117956	20.839546	117.112716	88330184	200968	20.828641	117.192537
87330132	130972	20.825379	117.124931	88330185	200968	20.828641	117.192537
87330133	191991	20.807968	117.183507	88330186	200968	20.828641	117.192537
87330134	193992	20.806755	117.185581	88330187	202968	20.828351	117.194151
87330135	195994	20.805443	117.187318	88330188	150971	20.826032	117.144460
87330136	196995	20.804042	117.188009	88330189	151970	20.826872	117.144778
87330137	196996	20.802876	117.188680	88330190	151969	20.827703	117.145298
87330138	197998	20.801394	117.188909	88330191	151969	20.828191	117.145385
87330139	202000	20.800005	117.194480	88330192	150968	20.828671	117.144607
87330140	202001	20.799119	117.194441	88330193	150966	20.830315	117.144436
87330141	201999	20.800576	117.193261	88330194	150965	20.831020	117.144379
87330142	200998	20.801182	117.191983	88330195	151964	20.832411	117.144678
87330143	198998	20.801066	117.190532	88330196	151957	20.839043	117.145146
87330144	197998	20.801095	117.189658	88330197	152956	20.839865	114.145742
87330145	197998	20.801095	117.189658	88330198	151957	20.838601	117.144751
87330146	189992	20.807076	117.181622	88330199	152955	20.840461	117.146118
87330147	187990	20.808533	117.179692	88330199	151958	20.838013	117.145395
87330148	185988	20.810143	117.177695	88330200	151958	20.837670	117.145202
87330149	183987	20.811835	117.175727	88330201	152959	20.837163	117.145999
87330150	179985	20.813275	117.171962	88330202	152959	20.836576	117.145980
87330151	176984	20.813856	117.169598	88330203	152960	20.835871	117.145902
87330152	143958	20.837983	117.137648	88330204	152961	20.835275	117.145757
87330153	144957	20.838289	117.138648	88330205	151962	20.834489	117.145122
87330154	144958	20.837259	117.138579	88330206	150962	20.833713	117.144429
87330155	144960	20.836139	117.138867	88330207	150963	20.833044	117.144419
87330156	145961	20.835100	117.138952	88330208	202964	20.832001	117.194300
87330157	145963	20.833093	117.139777	88330209	126967	20.829647	117.120792
87330158	145964	20.831955	117.139555	88330210	126967	20.829638	117.120792
87330159	146966	20.830345	117.140784	88330211	169992	20.807041	117.162460
87330160	146968	20.829117	117.140542	88330212	136969	20.828158	117.130690
87330161	146968	20.828846	117.140138	88330213	164995	20.803892	117.157143
87330162	146969	20.827797	117.140647	88330215	192134	20.678628	117.184349

* Grid reference locations on Sheet 2356 (Roebourne), 1: 100 000 Topographic Map Series.

Appendix 2: Analytical Methods

All analyses were carried out in the BMR laboratories. Major and most trace elements were determined by X-ray fluorescence spectrometry (XRFS) on Philips PW-1404 or PW-1450 equipment. Major elements were measured on glass fusion discs using the method of Norrish & Hutton (1969). Calibration was against international and secondary rock standards, using SiO_2 and CaO blanks. Matrix corrections, with alpha factors for the rhodium tube, were applied to all major oxides (as well as S). Na_2O was also analysed by atomic absorption spectrophotometry (AAS), the results agreeing well with the XRFS data; averages are given in the listings. Ferrous iron (FeO) was determined separately by titration with standard potassium dichromate solution, and Fe_2O_3 estimated by difference. Loss on ignition (LOI) was measured by igniting about 5 g of sample at 1050°C. Quoted LOI values are corrected for the FeO contents of the samples. Combined water (H_2O^+), moisture (H_2O^-), and total carbon (carbonate and carbon, quoted as CO_2) were determined gravimetrically.

Most trace elements (Ba, Rb, Sr, Pb, Th, U, Zr, Nb, Y, La, Ce, Nd, Pr, Sc, V, Cr, Sn, Ga, As, and Cl) were analysed by XRFS on powder pellets using the techniques of Norrish & Chappell (1977). Molybdenum, rhodium, and gold target X-ray tubes were used to give optimum excitation for different groups of elements. Synthetic standards were employed for calibration, except for Rb (NBS-70A and MA-N), Sr (AGV-1), V (AGV-1, BCR-1, and W-1), and Cr (PCC-1 and DTS-1). Mass absorption corrections utilised the Compton scatter method for wavelengths less than 1.74Å (Fe absorption edge), and coefficients calculated from major element compositions for longer wavelengths. Empirical interfering element corrections were made where necessary. Li, Ni, Cu, and Zn were determined with a Varian AA-975 spectrophotometer, Li being analysed by the method of standard addition. F was measured by specific ion electrode.

Estimated detection limits are given. Those for elements determined by XRFS were calculated at the 95 percent confidence level for detection of peak above background, using the relation given by Jenkins & de Vries (1967):

$$\text{detection limit} = \frac{3c}{(Rp-Rb)}\sqrt{\frac{Rb}{t}}$$

where, Rp = peak count rate (counts/sec),

Rb = background count rate (count/sec),

t = background counting time (secs),

c = element concentration.

The detection limits given are twice these calculated theoretical values, and are considered to be more realistic. Detection limits for elements for which there are significant inter-element corrections (e.g., Ba, Ce, Sc, Y) will probably be even higher.

Detection limits (in percent for major oxides and ppm for trace elements).

SiO2	0.006
TiO2	0.008
Al2O3	0.007
Fe2O3	0.005
MnO	0.004
MgO	0.006
CaO	0.0014
Na20	0.02
K2O	0.0004
P2O5	0.003
Ba	5
Li	2
Rb	1
Sr	1
Pb	2
Th	2
U	0.5
Zr	2
Nb	2
Y	1
La	3
Ce	4
Nd	2
Pr	3
Sc	2
V	2
Cr	2
Ni	2
Cu	2
Zn	1
Sn	2
Ga	1
As	0.5
S	12
F	200
Cl	4

Comparison of analyses of standard rocks with recommended values of Abbey (1983).

	GSP-1		BCR-1	
	BMR	Recom.	BMR	Recom.
SiO_2	67.97 (0.29)*	67.32	54.42 (0.16)	54.53
TiO_2	0.67 (0.004)	0.66	2.26 (0.015)	2.26
Al_2O_3	5.16 (0.08)	15.28	13.51 (0.06)	13.72
Fe_2O_3(t)	4.26 (0.016)	4.28	13.39 (0.03)	13.44
FeO	2.25	2.32	8.89	8.96
MnO	0.04	0.04	0.17	0.18
MgO	0.99 (0.015)	0.97	3.53 (0.012)	3.48
CaO	1.97 (0.006)	2.03	6.97 (0.06)	6.97
Na_2O	2.74	2.81	3.27 (0.05)	3.30
K_2O	5.56 (0.012)	5.51	1.71 (0.010)	1.70
P_2O_5	0.28	0.28	0.36	0.36
Ba	1300	1300	702	680
Li	25	30	11	14
Rb	253	250	46	47
Sr	237	240	329	330
Pb	54	54	14	14
Th	104	105	6	6
U	2.0	2.1	1.5	1.7
Zr	507	500	187	185
Nb	25	?23	13	?19
Y	28	29	37	40
La	165	195	29	27
Ce	391	360	55	53
Nd	187	?190	32 ?	26
Pr	46	?50	4	?7
Sc	8	7	31	33
V	49	54	416	420
Cr	11	12	6	15
Ni	7	9	7	10
Cu	30	33	17	16
Zn	91	105	117	125
Sn	8	?5	2	3
Ga	24	23	21	22
As	<0.5	<0.5	1.0	?0.8
S	400	?300	400	?400
F			500	500

* Standard deviation.

Precision and accuracy

Precision of the XRFS technique is generally good, as the effects of all but very short-term drift in machine conditions are practically eliminated by ratioing each measurement to a monitor standard. The precision (1 level) for trace element analyses is typically +3 percent at the 30 to 100 ppm level. The corresponding precision for AAS analyses is between +4 and+6 percent.

Accuracy was assessed by analysing international rock standards. Comparisons of XRFS and AAS results for two standard rocks (GSP-1 and BCR-1) are given in Table ii.

TABLE 1. STRATIGRAPHY OF THE ANDOVER COMPLEX

Subzone	Description	Estimated Thickness (m)
Gabbroic Zone		
	Medium to coarse-grained undifferentiated series of gabbro and anorthosite Norite at contact with ultramafic zone	800+
Ultramafic Zone		
G	Series of peridotite (Cr 0.13-0.25%) interlayered with orthopyroxenite, websterite, clinopyroxenite, olivine websterite and olivine orthopyroxenite horizons. Interfingering gabbro lenses are slivers of the gabbroic zone. Olivine orthopyroxenite and orthopyroxenite are the uppermost horizons in places and websterite in others. Olivine orthopyroxenites contain up to 1 percent disseminated chromite. Orthopyroxenites also contain relatively high (0.4-0.6 percent) Cr.	150
F	Series of peridotite (Cr 0.12-0.27%), interlayered lherzolite, olivine websterite	170
E	Series of peridotite (Cr 0.21-0.32%), lherzolite, anorthosite, massive anorthositic gabbro	200
D	Series of peridotite (Cr 0.26-0.36%), interlayered with low Cr (<0.3 percent Cr), sulphide-bearing orthopyroxenite, lherzolite; overlain by minor olivine websterite, websterite	180
C	Series of peridotite (Cr 0.25-0.41%), including minor lherzolite, orthopyroxenite, websterite layers, clinopyroxenite, gabbro, anorthosite, anorthositic gabbro.	200
B	Series of peridotite (Cr 0.30-0.46%), minor gabbro, massive laterally widespread anorthositic gabbro, norite	230
A	Series of peridotite (Cr 0.41- 0.52%), some containing up to 0.6 percent finely disseminated chromite, minor lenses of clinopyroxenite, websterite and gabbro. Sulphide-bearing norite at base	170
	Total Estimated Thickness (m)	2100

TABLE 2. MAJOR AND TRACE ELEMENT ANALYSES

Sample	86330001	86330002	86330003	86330004	86330005	86330006	86330007	86330008	86330009	86330010	86330011	86330012	86330013	86330014	86330015
Rock	peridotite	gabbro	gabbro	gabbro	dolerite	gabbro	titano-magnetite	websterite	anortho-site	anortho-gabbro	olivine gabbro	olivine gabbro	gabbro	gabbro	peridotite
SiO2	39.50	54.03	54.33	51.23	55.64	42.21	.39	52.74	42.62	49.44	48.34	48.49	55.99	49.12	37.25
TiO2	.03	.36	.89	.41	.46	3.19	29.70	.24	.09	.17	.20	.17	.53	.17	.08
Al2O3	.62	17.32	16.88	16.21	13.35	13.63	1.43	9.15	20.92	18.50	13.57	14.49	13.26	15.81	4.32
Fe2O3	8.50	1.10	1.84	1.16	1.60	5.77	46.89	1.48	1.96	.68	1.83	.82	1.33	.76	9.76
FeO	4.18	4.12	5.49	4.98	7.20	11.39	18.33	7.71	4.68	4.15	6.27	5.77	7.71	5.31	4.85
MnO	.29	.10	.13	.12	.16	.20	.50	.18	.09	.10	.14	.13	.16	.12	.15
MgO	35.38	5.50	5.21	8.81	8.06	6.22	1.67	17.16	10.11	9.37	15.10	13.21	7.15	11.65	30.77
CaO	<.01	9.41	8.41	9.70	8.44	11.26	.01	6.19	11.47	12.69	9.77	11.14	8.45	10.35	.96
Na2O	<.02	3.08	2.62	2.68	1.92	1.86	<.02	.94	.95	1.57	1.13	1.25	2.00	1.72	.21
K2O	<.01	1.14	.76	1.04	.82	.37	.07	.93	.02	.09	.09	.23	.34	.45	.02
P2O5	<.01	.03	.17	.03	.04	.02	.02	.01	<.01	<.01	<.01	<.01	.05	<.01	<.01
LOI	11.26	3.61	3.20	3.67	2.40	3.14	.82	2.51	6.18	2.99	3.34	3.90	2.65	3.73	11.12
Rest	.41	.18	.25	.24	.28	.49	.48	.53	.70	.29	.27	.23	.35	.26	.27
Total	100.17	99.98	100.18	100.28	100.37	99.75	100.31	99.77	99.79	100.04	100.05	99.83	99.97	99.45	99.76
Trace elements in parts per million															
Ba	4	253	267	254	282	114	-	170	12	49	45	98	188	142	21
Li	2	15	27	21	32	53	12	27	52	13	6	28	20	24	2
Rb	1	52	35	45	33	59	<1	67	2	5	5	15	17	41	1
Sr	1	229	397	236	118	281	<1	203	245	269	184	222	158	248	10
Pb	1	4	5	4	8	5	5	4	4	3	2	1	6	2	2
Th	1	4	5	2	4	1	<1	1	2	<1	<1	1	6	<1	<1
U	<.50	.50	.50	.50	.50	.50	2.00	<.50	<.50	<.50	<.50	<.50	1.00	<.50	<.50
Zr	2	60	133	53	71	17	147	34	5	9	14	7	83	8	4
Nb	<2	3	6	2	3	<2	29	<2	<2	<2	<2	<2	3	<2	<2
Y	2	18	22	11	15	10	1	9	1	4	5	5	16	5	1
La	3	11	24	9	14	<3	-	6	<3	4	5	<3	16	<3	<3
Ce	4	26	53	18	23	3	-	10	<3	4	6	<3	25	<3	<3
Nd	<3	13	24	7	10	3	-	4	<3	<3	3	<3	11	<3	<3
Sc	6	30	28	29	34	56	-	29	17	35	28	36	34	32	7
V	19	99	183	122	177	812	2000	131	39	91	82	96	188	91	26
Cr	769	54	450	229	653	<2	-	2345	640	932	666	797	564	590	168
Ni	2209	89	139	229	125	21	<2	330	695	186	391	252	114	315	1764
Cu	4	29	20	15	55	38	17	57	827	114	121	58	59	198	3
Zn	53	51	64	47	73	122	271	70	41	38	53	51	76	47	94
Ga	3	18	20	15	15	20	32	10	13	14	10	12	15	13	5
As	2.00	1.50	2.00	3.00	4.00	3.00	4.00	2.00	1.00	.50	1.00	.50	4.00	.50	1.00
S	<100	400	<100	600	400	2400	500	400	3500	400	500	<100	1300	200	<100

Sample	86330016	86330017	86330018	86330019	86330020	86330021	86330022	86330023	86330024	86330025	86330026	86330027	86330028	86330029	86330030
Rock	peridotite	peridotite	olivine orthopyxte	gabbro	dolerite	lherzolite	peridotite	lherzolite	peridotite	peridotite	peridotite	peridotite	norite	peridotite	peridotite
SiO2	37.19	37.02	45.41	49.13	50.01	41.73	38.45	41.27	37.91	36.10	31.35	35.47	49.00	39.06	35.33
TiO2	.12	.07	.08	.23	1.84	.20	.13	.15	.09	.09	.03	.17	.82	.07	.07
Al2O3	2.19	1.76	2.21	17.13	13.21	3.89	1.73	6.49	.59	1.41	18.32	2.05	15.24	.51	.34
Fe2O3	8.15	13.74	3.01	.74	2.65	4.76	6.32	6.11	13.58	15.00	1.23	14.05	2.76	12.07	15.64
FeO	7.43	4.50	5.80	4.61	9.46	6.96	8.26	6.90	2.40	.86	4.06	.60	8.22	3.12	2.64
MnO	.13	.18	.16	.10	.18	.17	.18	.17	.21	.13	.53	.15	.18	.43	.18
MgO	30.70	29.92	31.54	10.01	6.65	30.10	30.73	25.98	33.25	33.70	31.65	34.01	8.13	33.51	32.40
CaO	1.35	.36	<.01	10.37	10.72	1.81	1.64	4.40	.41	.09	.10	.06	11.58	.03	1.10
Na2O	.04	.23	.06	1.70	1.88	.19	.18	.28	.04	.02	<.02	.02	1.94	.04	<.02
K2O	<.01	.01	<.01	1.51	.07	.04	.01	.04	<.01	<.01	.01	<.01	.18	<.01	<.01
P2O5	<.01	<.01	.01	.01	.20	.03	<.01	.02	<.01	<.01	<.01	.03	<.01	<.01	<.01
LOI	12.15	11.59	9.36	4.26	3.02	9.94	11.82	8.24	11.59	12.39	13.09	11.87	1.95	11.05	11.84
Rest	.36	.33	1.80	.28	.31	.55	.59	.49	.84	.61	.25	1.57	.21	.46	.61
Total	99.81	99.71	99.44	100.08	100.20	100.37	100.04	100.54	100.91	100.40	100.62	100.05	100.21	100.35	100.15

Trace elements in parts per million

Ba	39	15	<3	316	23	22	7	221	26	6	15	7	43	13	30
Li	<2	3	3	69	43	3	3	3	3	2	26	2	5	<2	2
Rb	<1	1	1	300	2	2	1	1	1	<1	2	1	8	<1	<1
Sr	11	2	<1	235	275	16	7	51	8	2	<1	6	116	<1	3
Pb	2	2	<1	4	2	2	3	2	2	3	1	2	3	3	2
Th	1	<1	<1	2	1	1	1	<1	<1	<1	<1	<1	<1	1	1
U	<.50	<.50	<.50	1.00	1.00	.50	<.50	<.50	.50	<.50	<.50	<.50	<.50	<.50	<.50
Zr	8	3	8	28	149	27	7	18	<2	<2	<2	5	10	3	<2
Nb	<2	<2	<2	2	12	2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Y	2	1	1	14	25	5	2	3	<1	1	<1	2	11	2	<1
La	3	<3	<3	6	16	5	<3	4	<3	<3	<3	3	<3	<3	<3
Ce	4	<3	5	8	37	9	<3	5	4	3	<3	3	<3	<3	<3
Nd	<3	<3	<3	<3	22	4	<3	3	<3	<3	<3	<3	<3	<3	<3
Sc	10	11	7	31	37	9	12	16	8	7	3	7	47	14	7
V	34	36	59	97	316	52	57	57	56	47	9	92	327	44	48
Cr	529	386	10704	700	192	1818	1914	1485	4401	2863	651	8421	256	650	2980
Ni	1937	1919	1359	177	73	1905	1759	1524	1125	1303	1008	2152	131	2077	1152
Cu	16	14	363	54	85	10	5	111	72	31	8	19	95	530	30
Zn	83	106	33	38	106	110	105	92	81	64	91	165	84	107	91
Ga	3	3	2	14	19	6	3	7	2	1	5	3	16	1	1
As	22.00	1.00	2.50	17.00	1.00	14.00	1.50	1.00	1.50	1.00	.50	.50	1.50	1.00	1.00
S	<100	<100	<100	<100	1100	<100	600	<100	200	<100	<100	200	400	100	<100

Sample	86330031	86330032	86330033	86330034	86330035	86330036	86330037	86330038	86330039	86330040	86330041	86330042	86330043	86330044	86330045
Rock	peridotite	peridotite	olivine websterite	dolerite	peridotite	peridotite	peridotite	orthopyro- xenite	peridotite	peridotite	peridotite	peridotite	orthopyro- xenite	peridotite	peridotite
SiO2	38.05	37.07	45.65	50.15	38.57	37.40	36.52	53.17	36.40	35.30	39.36	38.04	53.09	37.95	37.07
TiO2	.05	.08	.17	.92	.05	.06	.04	.17	.06	.05	.10	.08	.23	.07	.06
Al2O3	.67	1.90	1.72	8.59	.92	4.18	.83	1.54	.67	.54	.74	.89	1.72	3.66	1.03
Fe2O3	13.28	12.03	3.01	1.38	10.59	7.35	14.55	3.09	13.99	16.12	9.34	11.02	1.36	8.78	11.80
FeO	2.83	2.22	7.65	9.74	2.81	4.74	1.19	7.53	1.18	1.25	1.32	4.13	9.68	3.39	1.08
MnO	.17	.14	.22	.20	.13	.17	.12	.23	.09	.13	.19	.38	.24	.18	.12
MgO	33.59	33.97	28.49	9.75	34.62	33.24	34.34	28.46	34.85	33.88	35.94	33.30	28.06	32.36	35.58
CaO	.04	.35	4.01	15.23	.04	.28	.01	2.07	.01	.02	.06	.02	2.27	1.93	.03
Na2O	.04	.04	.07	.79	<.02	.06	.05	.08	.03	.09	.02	.06	.08	.05	.02
K2O	<.01	<.01	<.01	.22	<.01	<.01	<.01	.01	<.01	<.01	<.01	<.01	.01	.01	<.01
P2O5	.02	<.01	<.01	.08	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
LOI	11.10	11.79	8.51	3.01	11.38	11.64	11.87	2.84	11.92	11.72	12.07	11.16	2.58	10.85	12.25
Rest	.46	.71	.62	.40	.86	.94	.80	.58	.59	.86	.73	.70	.63	.66	.79
Total	100.30	100.30	100.12	100.46	99.97	100.06	100.32	99.77	99.79	99.96	99.87	99.78	99.95	99.89	99.83

Trace elements in parts per million

Ba	10	14	4	200	11	68	7	21	6	6	9	13	15	21	20
Li	2	2	11	94	3	6	<2	17	2	<2	<2	<2	8	7	<2
Rb	<1	<1	20	80	1	2	1	10	<1	<1	<1	<1	5	5	1
Sr	2	4	7	408	5	12	2	17	1	1	7	2	7	14	3
Pb	1	1	3	5	1	2	2	3	2	2	1	2	2	1	2
Th	<1	<1	1	6	<1	<1	1	<1	1	<1	1	1	<1	<1	1
U	<.50	<.50	<.50	1.00	<.50	.50	<.50	<.50	<.50	<.50	1.50	<.50	<.50	.50	.50
Zr	2	2	2	113	<2	<2	<2	3	2	2	<2	<2	3	<2	<2
Nb	<2	<2	<2	7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Y	<1	2	3	17	1	1	1	3	<1	1	1	1	3	2	1
La	<3	3	<3	21	<3	<3	<3	<3	<3	<3	<3	<3	<3	4	<3
Ce	<3	3	<3	40	<3	<3	<3	<3	<3	<3	<3	<3	<3	4	<3
Nd	<3	<3	<3	19	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Sc	8	10	25	37	5	6	4	22	7	6	11	9	29	7	6
V	33	50	82	195	30	46	29	81	29	36	55	39	115	29	33
Cr	1738	2963	2743	1149	3610	3102	3537	2731	2608	3937	3038	2903	2403	2555	3272
Ni	1339	1804	948	274	2442	2662	2064	745	1415	1842	1767	1360	730	1842	2274
Cu	19	66	65	103	23	805	40	96	103	153	136	591	312	53	20
Zn	80	83	80	88	111	81	74	81	54	76	78	110	81	74	90
Ga	2	4	3	14	2	5	1	2	2	1	2	1	4	3	3
As	1.50	2.00	<.50	1.00	3.00	1.50	1.00	.50	1.00	1.00	4.00	1.00	.50	.50	1.00
S	100	100	500	<100	<100	200	<100	400	<100	100	200	<100	1100	200	<100

Sample	86330046	86330047	86330048	86330049	86330050	86330051	86330052	86330053	86330054	86330055	86330056	86330057	86330059	86330060	86330061
Rock	websterite	peridotite	peridotite	orthopyro-xenite	peridotite	peridotite	peridotite	lherzolite	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite
SiO2	46.58	38.37	38.03	51.59	38.40	38.85	38.64	40.07	37.79	36.25	38.61	40.85	35.82	31.01	36.61
TiO2	.25	.06	.07	.15	.06	.07	.05	.09	.10	.10	.09	.10	.05	.06	.03
Al2O3	10.92	.75	1.41	1.15	1.02	.86	.42	2.98	.64	.63	2.59	2.06	.87	18.10	1.66
Fe2O3	1.28	11.05	10.41	2.62	10.26	10.21	10.31	9.48	10.89	14.88	3.73	8.95	14.93	2.26	12.06
FeO	6.40	2.13	2.35	6.71	2.70	2.17	2.90	3.83	4.92	3.55	8.12	3.76	.24	3.31	3.19
MnO	.18	.15	.28	.20	.20	.15	.16	.21	.19	.08	.16	.18	.11	.26	.22
MgO	14.63	34.93	34.67	27.90	34.99	35.00	35.67	30.51	33.58	32.37	31.74	31.58	34.57	31.45	33.86
CaO	14.73	.11	.18	1.79	.01	.02	.03	2.48	.06	.35	1.42	1.88	.01	<.01	<.01
Na2O	.24	.03	<.02	.08	<.02	.03	.06	.15	.04	.03	.04	.10	.06	<.02	.08
K2O	.02	<.01	<.01	.01	<.01	<.01	<.01	<.01	<.01	<.01	.02	.03	.01	<.01	<.01
P2O5	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.01	<.01	<.01	<.01	<.01	<.01
LOI	4.27	11.42	11.77	7.33	11.50	12.07	11.40	9.46	11.01	11.16	12.55	9.72	12.34	12.99	11.36
Rest	.39	.70	.78	.48	.68	.66	.65	.62	.67	.47	.67	.67	.82	.16	.55
Total	99.89	99.70	99.95	100.01	99.82	100.09	100.29	99.88	99.89	99.88	99.74	99.88	99.83	99.60	99.62

Trace elements in parts per million

Ba	79	7	32	14	7	20	9	38	10	15	10	16	7	42	11
Li	59	<2	2	4	<2	<2	<2	7	<2	2	3	5	2	21	2
Rb	<1	<1	1	<1	<1	<1	<1	1	<1	<1	2	1	<1	<1	<1
Sr	146	1	10	3	8	1	1	27	2	6	6	9	1	1	1
Pb	2	1	1	1	1	2	<1	3	2	3	2	1	1	<1	2
Th	<1	<1	1	<1	<1	2	2	1	<1	<1	1	<1	<1	<1	<1
U	.50	<.50	<.50	<.50	<.50	.50	<.50	<.50	<.50	<.50	.50	<.50	<.50	<.50	.50
Zr	5	<2	2	3	3	3	2	2	3	4	3	4	<2	3	<2
Nb	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Y	6	<1	1	2	<1	1	1	1	2	1	2	2	<1	<1	1
La	<3	<3	<3	<3	3	<3	<3	<3	<3	<3	3	<3	3	<3	<3
Ce	3	<3	4	<3	3	<3	<3	<3	<3	<3	5	4	4	<3	<3
Nd	3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Sc	48	6	5	18	6	7	5	11	11	8	10	11	6	13	4
V	131	41	29	59	32	35	29	47	50	38	39	45	44	44	25
Cr	1782	3404	3013	2304	2944	2713	2837	2520	2569	1467	2557	2798	3579	642	2131
Ni	230	1397	2011	558	1730	1762	1689	1434	1618	1572	1691	1613	2171	268	1659
Cu	128	11	31	401	16	115	49	204	402	265	151	197	4	6	9
Zn	51	104	124	76	119	92	85	82	88	70	77	80	79	70	109
Ga	10	2	3	3	2	2	1	3	2	1	5	4	2	7	3
As	1.00	1.50	1.50	.50	1.00	4.50	1.00	<.50	1.00	.50	.50	2.00	1.50	.50	1.00
S	<100	<100	500	<100	<100	<100	<100	100	100	<100	400	100	<100	<100	<100

Sample	86330062	86330063	86330064	86330065	86330066	86330067	86330068	86330069	86330070	86330071	86330072	86330073	86330074	86330075	86330076
Rock	peridotite	peridotite	peridotite	peridotite	anorthosite	peridotite	orthopyroxenite	gabbro	olivine orthopyxte	peridotite	peridotite	peridotite	clinopyroxenite	peridotite	peridotite
SiO2	37.82	37.98	36.20	-	41.67	39.80	52.35	48.27	45.51	36.55	38.38	36.96	50.93	35.50	38.24
TiO2	.08	.11	.05	.11	.13	.08	.15	.45	.08	.09	.07	.05	.29	.05	.05
Al2O3	3.45	2.57	2.32	3.08	17.93	1.31	4.43	17.15	2.31	1.12	.81	1.16	3.11	.77	.43
Fe2O3	9.59	8.80	12.41	10.03	.95	7.15	1.22	1.59	5.48	11.52	10.66	14.17	1.32	15.61	11.82
FeO	3.77	3.12	.77	3.02	4.62	3.92	7.66	4.84	3.86	3.36	2.38	2.27	5.43	.48	3.67
MnO	.17	.18	.09	.17	.28	.14	.18	.11	.17	.17	.16	.18	.16	.12	.10
MgO	32.49	34.36	34.85	33.16	11.39	35.08	24.68	8.49	32.27	33.37	34.73	33.52	18.06	34.32	33.69
CaO	.58	.23	.01	.76	17.08	.02	3.19	13.17	1.45	.79	.23	.11	16.83	.14	.03
Na2O	.10	.02	.06	.09	.24	.03	.23	1.94	.03	.05	.05	.10	.32	.02	.05
K2O	.02	.03	<.01	.02	.03	<.01	.04	.22	.03	<.01	<.01	<.01	.01	<.01	<.01
P2O5	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.01	<.01	<.01	<.01	.01	<.01	<.01	<.01
LOI	11.40	11.66	12.38	11.20	5.93	11.76	5.40	3.69	7.83	12.17	11.78	11.24	2.86	12.12	11.06
Rest	.51	.56	.66	.60	.23	.66	.65	.30	1.09	.69	.62	.71	.51	1.07	.44
Total	99.98	99.62	99.80	62.24	100.48	99.95	100.18	100.23	100.11	99.88	99.87	100.48	99.83	100.20	99.58

Trace elements in parts per million

Ba	23	15	11	37	19	6	6	64	8	5	8	19	19	8	15
Li	5	3	4	4	82	2	7	19	7	2	<2	<2	10	<2	<2
Rb	2	<1	<1	4	1	<1	4	7	4	<1	<1	1	1	<1	1
Sr	7	9	2	11	142	2	55	358	5	5	4	6	22	1	3
Pb	3	1	2	2	1	1	3	2	1	1	2	2	3	1	4
Th	1	1	<1	<1	<1	<1	1	1	<1	<1	<1	<1	1	1	<1
U	<.50	<.50	<.50	<.50	<.50	<.50	<.50	.50	<.50	<.50	<.50	<.50	<.50	<.50	<.50
Zr	3	4	3	4	4	2	12	16	7	5	4	3	16	2	<2
Nb	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Y	2	1	1	1	3	<1	4	8	2	2	1	<1	8	<1	1
La	<3	<3	3	3	<3	<3	<3	5	3	<3	<3	3	3	3	<3
Ce	<3	3	3	4	<3	<3	<3	9	5	<3	<3	3	8	4	<3
Nd	<3	<3	<3	<3	<3	<3	<3	6	<3	<3	<3	<3	4	<3	<3
Sc	10	9	6	8	32	9	22	42	12	10	10	7	69	5	9
V	40	48	36	42	70	44	104	164	58	34	32	32	177	42	28
Cr	2192	2445	2858	2401	768	3078	3688	810	6464	2984	2664	3154	2508	5187	1194
Ni	1291	1314	1389	1675	249	1337	400	147	849	1644	1454	1463	355	2297	1883
Cu	19	26	388	22	92	49	26	69	15	79	11	25	239	3	20
Zn	87	74	48	78	46	73	65	46	53	78	60	76	36	72	43
Ga	4	3	2	4	12	2	5	14	3	2	1	1	5	2	2
As	1.50	1.00	1.50	1.00	1.50	1.00	.50	<.50	1.00	2.50	2.00	3.00	1.00	1.50	.50
S	<100	100	<100	100	100	100	100	500	100	100	300	400	100	<100	100

Sample	86330077	86330078	86330079	86330080	86330081	86330082	86330083	86330084	86330085	86330086	86330087	86330088	86330089	86330090	86330091
Rock	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite	anortho-site	gabbro
SiO2	36.94	37.46	38.11	36.70	37.07	36.30	36.09	35.94	36.81	36.79	36.82	37.42	137.09	47.95	51.38
TiO2	.06	.08	.10	.06	.08	.05	.06	.08	.09	.09	.14	.10	.12	.20	.19
Al2O3	.50	.94	.66	2.19	1.22	5.28	2.44	2.21	3.14	2.40	1.13	2.36	1.57	20.40	11.45
Fe2O3	13.37	12.62	10.59	9.58	12.01	8.72	11.89	12.62	9.66	11.95	12.56	10.91	13.42	.57	.63
FeO	2.50	2.50	4.76	2.86	.67	2.36	3.07	1.81	3.00	2.75	1.91	2.34	1.79	3.98	5.12
MnO	.24	.20	.13	.13	.09	.10	.15	.17	.27	.12	.16	.22	.22	.09	.13
MgO	34.18	34.31	33.67	33.86	35.34	33.74	33.17	34.23	34.54	33.64	34.85	34.32	33.27	5.91	13.80
CaO	<.01	<.01	.01	.92	.19	.01	.34	.05	.04	.04	.02	.03	.13	12.55	11.84
Na2O	.05	.06	.05	.03	.07	<.02	.03	.03	.04	.02	.04	.04	.07	2.66	1.61
K2O	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.84	.44
P2O5	<.01	<.01	<.01	<.01	.01	<.01	<.01	.01	.02	<.01	<.01	<.01	<.01	<.01	<.01
LOI	11.24	11.10	11.02	12.66	12.33	12.46	12.07	11.97	11.47	11.28	11.61	11.52	11.39	4.58	2.79
Rest	.89	.78	.71	.73	.93	.83	.60	.65	.70	.84	.70	.91	.82	.18	.37
Total	99.97	100.05	99.81	99.72	100.01	99.85	99.91	99.77	99.78	99.92	99.94	100.17	199.89	99.91	99.75
	Trace elements in parts per million														
Ba	6	9	7	14	11	15	10	18	9	13	11	12	50	231	47
Li	<2	<2	<2	2	<2	2	4	<2	<2	<2	<2	2	2	54	349
Rb	1	1	2	5	2	2	7	1	1	1	<1	1	2	59	349
Sr	2	<1	2	5	3	2	4	4	3	1	3	1	14	431	524
Pb	3	1	2	3	2	1	3	2	1	3	1	1	2	4	2
Th	<1	<1	<1	1	<1	1	<1	1	1	1	<1	<1	1	<1	<1
U	<.50	<.50	<.50	<.50	<.50	<.50	<.50	<.50	<.50	<.50	<.50	.50	<.50	<.50	<.50
Zr	<2	<2	<2	2	2	<2	2	4	4	<2	3	<2	3	5	6
Nb	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Y	<1	<1	1	2	1	1	2	1	1	<1	2	1	1	6	14
La	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	3
Ce	4	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	3
Nd	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	3
Sc	5	5	8	8	6	5	8	6	9	6	7	7	10	40	43
V	42	44	44	33	37	33	40	34	41	49	53	50	47	126	120
Cr	3691	3409	3076	2959	4109	3286	2247	2587	3126	3719	2758	4174	3760	147	733
Ni	2564	2006	1906	1946	2156	2375	1917	1827	1679	2024	2042	1866	1245	39	310
Cu	3	4	3	39	237	159	2	6	3	20	18	40	67	42	18
Zn	104	99	83	77	60	76	87	67	93	65	64	91	106	26	44
Ga	2	2	2	3	3	4	3	3	3	5	4	2	2	16	11
As	2.50	2.00	.50	23.00	77.00	13.00	.50	1.50	.50	2.50	1.50	1.50	1.00	<.50	1.00
S	<100	<100	<100	200	<100	100	<100	200	100	200	100	300	700	200	<100

Sample	86330092	86330094	86330095	86330096	86330097	86330098	86330099	86330100	86330101	86330102	86330103	86330104	86330105	86330106	86330107
Rock	lherzolite	gabbro	tonalite	dolerite	anorthosite	tonalite	gabbro	peridotite	gabbro	peridotite	anorthosite	schist	anorthogabbro	peridotite	anorthosite
SiO2	40.06	50.53	70.87	49.34	49.31	62.03	47.17	36.99	48.08	36.52	48.56	27.23	41.59	36.33	48.21
TiO2	.11	.45	.36	.39	1.21	.60	.39	.18	.31	.12	.19	.33	.14	.08	.21
Al2O3	5.59	17.04	14.31	17.23	20.59	17.64	13.70	.43	14.98	2.43	20.48	22.21	19.82	.68	20.40
Fe2O3	9.07	1.27	.69	1.49	2.89	1.82	1.47	15.37	.78	11.80	.63	1.37	1.11	12.61	1.63
FeO	4.16	5.31	1.19	7.16	4.84	3.05	8.00	2.24	6.06	3.71	3.25	12.59	4.76	2.78	4.18
MnO	.21	.15	.03	.12	.11	.08	.18	.25	.15	.15	.09	.16	.18	.09	.11
MgO	26.64	7.96	.82	5.59	3.50	1.63	13.92	32.91	9.29	33.63	6.70	23.98	9.76	32.87	7.34
CaO	4.47	10.06	3.01	4.73	10.27	5.11	6.11	.11	15.56	.02	12.18	.12	15.20	1.15	12.38
Na2O	.05	1.61	4.67	2.11	3.55	4.55	1.40	.17	.90	.10	2.65	.05	.54	.04	1.56
K2O	.01	1.68	1.54	1.85	.62	1.05	1.62	<.01	.42	<.01	.90	<.01	.07	.01	.10
P2O5	<.01	.05	.06	.06	.09	.17	.04	.01	<.01	.01	<.01	<.01	<.01	<.01	<.01
LOI	9.05	3.71	1.95	7.93	2.70	2.08	5.09	10.70	3.62	10.83	4.14	12.22	6.00	12.39	3.98
Rest	.74	.32	.15	1.53	.34	.22	.19	.77	.21	.70	.19	.29	.80	.69	.28
Total	100.16	100.14	99.65	99.53	100.02	100.03	99.28	100.13	100.36	100.02	99.96	100.55	99.97	99.72	100.38
	Trace elements in parts per million														
Ba	15	445	472	244	338	424	408	22	106	11	227	8	259	23	26
Li	15	17	6	35	85	50	32	<2	48	2	51	77	151	<2	135
Rb	1	73	40	94	112	55	86	<1	17	<1	83	<1	5	<1	11
Sr	32	306	210	92	387	488	115	6	260	2	510	<1	316	16	640
Pb	3	10	11	3	6	12	2	2	2	1	2	<1	20	2	13
Th	1	2	14	3	2	6	2	31	2	1	<1	<1	1	<1	1
U	<.50	<.50	3.00	1.00	<.50	.50	.50	.50	<.50	.50	<.50	<.50	<.50	<.50	<.50
Zr	3	38	298	52	36	231	57	<2	6	3	7	5	5	<2	6
Nb	<2	2	9	2	2	9	2	<2	<2	<2	<2	<2	<2	<2	<2
Y	2	11	15	13	14	32	12	1	7	1	7	5	3	1	3
La	<3	9	16	110	14	37	9	<3	<3	<3	4	4	3	<3	3
Ce	<3	13	27	115	23	68	17	<3	<3	<3	3	8	3	<3	3
Nd	<3	8	9	48	10	28	8	<3	<3	<3	<3	3	<3	<3	<3
Sc	17	35	6	21	30	15	20	9	50	8	36	43	34	6	29
V	75	126	30	99	371	86	105	67	153	48	100	142	87	37	86
Cr	3534	428	6	212	255	6	69	2993	533	3234	189	1139	379	3084	392
Ni	1332	123	20	126	53	11	332	1917	140	1609	112	419	1923	1614	276
Cu	74	54	17	10740	21	26	23	14	109	17	74	9	2370	18	138
Zn	59	63	25	139	55	65	58	107	52	76	29	111	43	72	44
Ga	5	15	15	18	21	23	14	3	12	3	17	15	16	1	17
As	.50	2.00	1.00	5.00	2.00	1.00	1.00	1.50	1.00	.50	1.00	.50	13.00	2.50	.50
S	100	900	<100	<100	900	100	100	500	<100	<100	<100	<100	700	100	300

Sample	86330108	86330109	86330110	86330111	86330113	86330114	86330115	86330116	86330117	86330118	86330119	86330120	86330121	86330122	87330124
Rock	anortho-gabbro	anortho-site	calc silicate	calc silicate	gabbro	komatiite	amphibo-lite	gabbro	tonalite	norite	norite	norite	tholeiite	gabbro	gabbro
SiO2	47.53	45.29	39.10	34.59	44.91	47.29	50.35	49.46	65.02	49.05	50.41	49.37	47.05	49.64	45.49
TiO2	.22	.13	.08	.03	.22	.11	1.12	.61	.81	.30	.36	.33	2.00	.25	.13
Al2O3	18.14	21.21	20.89	21.28	15.55	1.48	8.09	16.79	15.63	13.01	13.16	12.88	16.13	16.61	17.69
Fe2O3	1.18	.90	.76	1.64	1.23	1.57	2.45	1.42	1.57	1.43	1.42	1.51	3.49	.75	1.10
FeO	5.46	2.82	1.32	4.57	5.73	5.19	11.05	7.08	4.04	7.19	7.87	7.73	9.53	4.45	3.57
MnO	.12	.07	.19	.23	.12	.13	.28	.16	.07	.18	.19	.19	.29	.11	.10
MgO	8.24	6.47	4.01	9.48	14.02	31.02	10.93	7.41	1.57	11.92	12.24	12.41	6.07	10.07	9.82
CaO	13.27	18.79	29.22	22.10	12.38	1.94	10.94	11.46	4.59	12.05	12.29	11.99	8.51	12.34	14.30
Na2O	1.64	.28	.05	.04	1.57	.06	1.75	2.10	3.67	1.06	1.18	.98	2.62	1.59	1.15
K2O	.14	.84	<.01	.13	.11	<.01	.45	.42	1.36	.07	.03	.08	1.70	.87	1.65
P2O5	<.01	<.01	<.01	<.01	<.01	<.01	.10	.04	.14	<.01	<.01	<.01	.06	.01	.02
LOI	3.82	3.61	2.04	5.69	3.82	10.41	2.25	3.16	1.97	3.34	.98	2.46	2.73	3.30	3.71
Rest	.24	.25	.13	.20	.64	.51	.45	.35	.20	.37	.37	.29	.33	.43	1.31
Total	100.00	100.66	97.79	99.98	100.30	99.71	100.21	100.46	100.64	99.97	100.50	100.22	100.51	100.42	100.04

Trace elements in parts per million

Ba	38	219	26	46	88	451	165	127	628	31	30	26	577	186	1933
Li	58	48	68	407	1139	4	47	132	104	68	11	51	105	57	2004
Rb	14	73	<1	17	14	<1	22	101	55	20	8	49	280	111	2258
Sr	340	441	21	1	296	21	184	297	255	191	207	215	194	366	2148
Pb	1	1	2	1	3	2	4	3	4	1	1	2	9	4	2
Th	<1	<1	<1	<1	1	1	1	1	4	<1	<1	1	<1	1	<1
U	<.50	.50	<.50	<.50	<.50	<.50	<.50	<.50	1.00	<.50	<.50	<.50	<.50	<.50	1.00
Zr	8	5	4	<2	13	7	111	35	192	10	11	10	41	19	10
Nb	<2	<2	<2	<2	<2	<2	4	2	11	<2	<2	<2	3	<2	<1
Y	6	6	2	1	6	3	19	14	17	8	8	9	22	9	21
La	<3	<3	<3	<3	3	<3	11	8	23	4	3	<3	4	5	<3
Ce	3	<3	4	<3	4	4	27	11	46	4	7	<3	6	6	<3
Nd	<3	<3	3	<3	<3	<3	17	7	18	4	3	<3	7	5	<3
Sc	42	45	34	17	38	9	38	43	19	49	46	46	44	40	36
V	121	91	47	8	113	50	225	240	111	174	182	181	438	118	96
Cr	242	559	381	401	1562	1486	1656	105	3	347	361	457	26	1796	631
Ni	146	139	114	266	541	1626	497	119	3	297	294	338	40	266	131
Cu	124	76	146	3	123	23	34	44	4	89	82	68	56	22	93
Zn	37	20	19	84	40	50	144	60	56	58	69	65	138	40	28
Ga	13	14	10	9	11	3	12	16	19	12	13	12	21	14	13
As	1.00	1.00	1.00	1.50	.50	5.50	2.00	.50	1.00	1.00	1.00	.50	3.50	5.00	1.00
S	800	200	<100	<100	<100	100	<100	1600	<100	1800	1800	800	600	<100	100

Sample	87330125	87330126	87330127	87330128	87330129	87330130	87330131	87330132	87330133	87330134	87330135	87330136	87330137	87330138	87330139
Rock	anortho-site	gabbro	gabbro	gabbro	dolerite	gabbro	anortho-site	anortho-site	peridotite	peridotite	peridotite	websterite	peridotite	peridotite	clinopyro-xenite
SiO2	51.07	49.39	44.63	49.33	52.51	44.78	46.03	47.42	36.10	37.20	36.60	44.07	36.13	36.23	54.24
TiO2	.31	.45	2.02	1.16	.34	.25	.32	.32	.11	.08	.16	.15	.09	.11	.25
Al2O3	20.19	14.08	15.02	15.22	12.65	13.09	20.38	20.38	1.18	3.89	1.87	13.24	3.05	2.16	1.65
Fe2O3	1.58	2.26	4.62	2.07	1.57	1.68	1.14	1.14	13.79	9.41	10.94	.94	10.99	11.70	2.10
FeO	4.00	6.35	10.56	8.08	6.54	7.47	3.76	3.76	.69	2.42	1.07	3.84	2.30	1.40	7.71
MnO	.11	.15	.20	.19	.16	.15	.11	.11	.12	.19	.02	.10	.15	.15	.25
MgO	6.25	11.99	5.88	7.09	10.78	14.30	6.40	6.40	34.56	32.04	35.22	14.84	33.91	34.97	20.36
CaO	9.77	8.70	10.12	9.78	9.54	11.83	12.63	12.63	.03	2.71	.04	17.05	.18	.09	10.12
Na2O	2.82	1.03	2.20	2.97	1.64	.82	2.32	2.32	.12	.13	.09	1.24	.09	.11	.37
K2O	.15	.05	.53	.33	.14	.04	.54	.54	<.01	<.01	<.01	.04	<.01	<.01	.01
P2O5	.05	.05	.35	.12	.05	.02	.03	.03	.01	<.01	.01	.02	<.01	<.01	.02
LOI	3.83	5.35	3.75	3.37	4.12	5.49	4.79	4.79	12.26	11.33	12.36	4.07	11.85	12.22	3.18
Rest	.17	.28	.39	.33	.34	.40	.32	.21	.88	.95	.98	.55	.80	.86	.53
Total	100.30	100.13	100.27	100.04	100.38	100.32	98.77	100.05	99.85	100.35	99.36	100.15	99.54	100.00	100.79

Trace elements in parts per million

Ba	90	21	353	166	73	12	1139	195	8	38	11	43	13	8	22
Li	12	16	5	18	37	53	20	62	1	19	2	413	3	6	7
Rb	3	2	13	8	5	1	137	29	3	1	3	3	3	<1	<1
Sr	293	264	313	246	238	176	478	255	2	5	4	290	2	3	7
Pb	3	4	5	4	8	7	3	6	2	1	1	2	<1	1	2
Th	<1	1	<1	1	3	<1	<1	<1	<1	<1	<1	<1	<1	1	<1
U	.50	.50	<.50	.50	1.00	<.50	<.50	<.50	<.50	<.50	<.50	.50	<.50	<.50	.50
Zr	27	21	25	31	42	8	10	11	6	3	7	6	6	4	2
Nb	1	2	2	4	2	<1	1	<1	1	<1	<1	1	1	1	<1
Y	6	6	19	16	10	6	6	6	2	1	2	3	2	1	4
La	5	4	10	6	8	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Ce	8	7	19	17	16	<3	6	4	<3	<3	4	<3	3	4	3
Nd	4	3	13	12	6	<3	3	4	<3	<3	3	<3	<3	3	<3
Sc	21	28	35	39	32	37	15	30	6	11	9	42	7	9	43
V	79	118	445	287	151	120	39	115	46	45	56	105	39	54	164
Cr	126	215	51	103	1263	814	439	448	3605	4557	4718	2087	3278	4212	2166
Ni	110	238	72	85	223	209	72	88	2530	1733	1899	435	2300	1737	827
Cu	126	197	42	30	60	108	89	50	<1	3	3	157	<1	10	366
Zn	52	68	129	87	63	57	14	36	57	85	75	30	49	60	87
Ga	17	13	22	17	12	12	17	16	2	5	4	8	3	3	4
As	1.50	3.50	1.00	1.00	2.50	1.00	1.50	4.50	<.50	.50	1.00	1.50	1.50	.50	2.00
S	400	1100	1700	1700	200	1700	200	200	100	300	200	100	100	<100	50

Sample	87330140	87330141	87330142	87330143	87330144	87330145	87330146	87330147	87330148	87330149	87330150	87330151	87330152	87330153	87330154
Rock	peridotite	gabbro	gabbro	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite	peridotite	gabbro	websterite	clinopyro-xenite
SiO2	36.37	48.55	48.67	37.95	37.11	36.30	37.34	35.72	36.31	37.09	38.98	36.80	49.59	51.59	52.70
TiO2	.09	.23	.21	.21	.13	.11	.15	.08	.10	.10	.11	.07	.25	.42	.31
Al2O3	1.26	16.00	16.22	1.45	2.18	2.00	1.06	2.62	1.85	.77	1.51	1.08	17.04	10.82	3.09
Fe2O3	14.85	1.23	.85	13.89	12.64	11.62	13.90	13.53	12.22	14.64	9.93	13.17	1.09	1.36	1.18
FeO	1.79	5.18	4.55	2.54	2.44	1.97	1.55	.69	1.22	2.41	2.18	1.03	5.59	7.74	6.50
MnO	.20	.14	.13	.21	.18	.15	.23	.16	.20	.21	.13	.12	.14	.16	.16
MgO	33.31	10.37	9.63	31.32	33.27	34.84	33.84	33.35	34.40	33.33	34.97	34.44	9.22	13.36	20.33
CaO	.06	12.63	14.64	1.53	.06	.03	.09	.20	.04	.02	.08	.05	9.95	7.56	11.47
Na2O	.11	1.67	1.77	.14	.11	.11	.10	.12	.14	.11	.09	.09	2.57	1.78	.30
K2O	<.01	.29	.27	.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.72	.22	.02
P2O5	.01	.02	.02	.01	<.01	<.01	<.01	.01	.01	<.01	.03	.01	.02	.05	.02
LOI	11.02	3.89	3.03	10.63	11.38	12.26	11.10	12.52	12.34	10.88	11.48	11.95	3.75	4.35	3.64
Rest	.98	.34	.32	.69	.69	.75	.76	.96	.83	.72	.86	.89	.22	.49	.48
Total	100.05	100.54	100.31	100.58	100.19	100.14	100.12	99.96	99.66	100.28	100.35	99.70	100.15	99.90	100.20

Trace elements in parts per million

Ba	13	389	96	18	3	10	76	12	20	11	32	24	263	0	7
Li	2	320	223	4	2	5	3	16	2	2	1	2	60	67	5
Rb	1	130	79	2	2	<1	1	1	<1	1	<1	1	89	21	28
Sr	1	334	395	7	<1	1	10	1	4	<1	6	6	386	109	14
Pb	3	-	2	2	1	1	2	2	2	2	2	3	2	14	4
Th	1	1	<1	<1	<1	<1	<1	<1	1	<1	1	1	<1	4	<1
U	.50	.50	<.50	<.50	<.50	<.50	<.50	<.50	<.50	.50	<.50	<.50	<.50	1.50	<.50
Zr	<2	7	6	4	3	3	2	<2	2	<2	2	<2	12	60	16
Nb	<1	<1	<1	1	<1	<1	1	<1	1	<1	<1	<1	1	3	<1
Y	2	8	6	3	2	2	<1	1	1	<1	6	1	8	14	10
La	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	12	<3
Ce	<3	<3	<3	3	<3	<3	<3	<3	<3	<3	<3	<3	4	22	9
Nd	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	3	11	8
Sc	10	41	47	16	9	9	6	9	8	4	5	5	38	27	41
V	62	135	193	90	62	52	61	69	52	42	55	34	131	160	124
Cr	4358	446	650	3048	3234	3295	3863	4097	3186	3611	3637	3647	375	2121	1813
Ni	2292	184	209	1391	1293	1707	1049	2288	2373	1236	2238	2503	122	442	756
Cu	<1	192	114	15	67	201	27	252	96	16	<1	9	32	59	456
Zn	109	46	41	102	67	65	124	77	99	105	74	82	57	71	78
Ga	2	12	13	3	3	3	3	3	2	2	3	3	15	13	22
As	2.50	1.00	.50	1.50	2.00	.50	1.00	.50	1.50	2.50	5.00	1.00	.50	1.50	1.50
S	200	200	200	300	200	60	200	50	200	50	200	200	100	300	100

Sample	87330155	87330156	87330157	87330158	87330159	87330160	87330161	87330162	87330163	87330164	87330165	87330166	87330167	88330168	88330170
Rock	gabbro	clinopyro- xenite	peridotite	orthopyro- xenite	peridotite	olivine websterite	anortho- site	lherzolite	peridotite	anortho- site	olivine orthopyxte	websterite	dolerite	aplite	norite
SiO2	46.00	50.66	36.36	51.03	39.85	48.82	43.64	39.04	38.75	47.21	43.07	52.01	47.57	74.01	52.45
TiO2	1.66	.41	.29	.18	.14	.27	.11	.15	.10	.31	.16	.39	.96	.02	.38
Al2O3	15.14	3.59	1.19	3.79	2.03	4.04	22.23	4.59	2.46	20.51	4.34	10.52	8.61	15.39	11.98
Fe2O3	2.96	1.61	14.30	2.58	11.86	4.34	.89	9.18	4.28	1.02	3.76	1.13	1.76	.09	1.35
FeO	10.42	8.24	3.31	9.10	3.82	6.05	3.71	3.97	9.19	3.82	7.37	7.47	10.12	.31	6.97
MnO	.19	.22	.18	.24	.18	.17	.08	.18	.17	.09	.17	.15	.26	.31	.14
MgO	6.98	18.76	31.77	25.51	29.25	23.10	8.96	29.03	31.07	6.50	28.41	14.06	11.26	.12	12.03
CaO	9.00	12.07	.12	2.87	2.40	8.24	12.34	3.74	1.41	13.54	3.27	7.85	14.94	.09	8.42
Na2O	83.00	.33	.14	.21	.27	.43	1.74	.20	.08	1.90	.28	.76	.28	7.60	1.75
K2O	.36	.02	<.01	.07	.02	.08	1.82	.05	<.01	.16	.01	.03	.03	1.10	.51
P2O5	.08	.02	.06	<.01	.02	.02	.02	.01	<.01	.04	.01	.04	.11	.01	.04
LOI	3.47	3.49	11.13	3.82	10.06	4.19	4.12	9.55	11.98	4.81	8.70	5.08	4.04	.58	3.22
Rest	.22	.39	.88	.57	.40	.34	.39	.58	.47	.30	.62	.62	.34	.14	.50
Total	179.48	99.81	99.73	99.97	100.30	100.09	100.05	100.27	99.96	100.21	100.17	100.11	100.28	99.77	99.74

Trace elements in parts per million

Ba	99	12	4	12	<3	69	238	33	3	36	36	23	90	74	156
Li	46	7	2	12	5	16	737	18	1	33	1	70	40	0	0
Rb	28	<1	1	15	1	10	202	6	1	8	1	2	1	762	196
Sr	404	23	4	61	17	77	439	57	9	289	17	132	26	23	159
Pb	4	1	2	3	2	2	4	3	2	2	1	10	4	6	8
Th	<1	<1	<1	<1	1	<1	1	<1	<1	1	<1	6	5	4	2
U	<.50	<.50	.50	<.50	<.50	<.50	<.50	<.50	<.50	.50	.50	1.00	.50	<.50	.50
Zr	25	10	10	4	9	8	6	4	2	16	4	50	101	30	54
Nb	3	<1	1	1	1	<1	<1	<1	<1	1	1	3	7	78	2
Y	17	11	3	2	5	8	7	2	1	7	3	11	14	13	14
La	3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	9	21	<2	9
Ce	12	6	<3	<3	8	5	<3	<3	<3	7	<3	18	39	6	24
Nd	8	5	<3	<3	5	4	<3	<3	<3	4	<3	8	19	3	8
Sc	43	57	9	25	15	32	15	14	12	31	16	27	33	<1	30
V	565	203	60	92	47	89	27	56	40	115	74	152	200	<2	159
Cr	41	1687	4133	2701	1032	1170	324	2230	642	817	2512	2621	1258	1	1765
Ni	36	393	1964	520	1531	862	383	1435	1097	82	993	479	295	8	421
Cu	<1	63	25	229	<1	<1	37	32	39	84	129	56	56	5	76
Zn	102	86	73	88	116	92	32	79	134	33	86	68	95	103	75
Ga	22	6	3	4	3	6	14	5	3	15	6	12	12	69	12
As	4.50	.50	4.00	1.00	1.50	1.00	7.50	<.50	8.50	1.00	1.50	1.50	2.00	.50	1.50
S	<100	200	<100	300	200	<100	100	300	2000	800	800	800	100	<10	610

Sample	88330171	88330172	88330173	88330174	88330175	88330176	88330177	88330178	88330179	88330180	88330181	88330182	88330183	88330184	88330185
Rock	anortho-gabbro	mica schist	anortho-gabbro	gabbro	anortho-gabbro	anortho-gabbro	gabbro	amphibo-lite	peridotite	peridotite	peridotite	peridotite	amphibo-lite	mica schist	websterite
SiO2	48.02	42.24	48.23	49.30	47.21	47.44	50.59	45.86	37.38	36.82	37.44	36.22	47.46	44.19	49.69
TiO2	.21	.06	.20	.29	.22	.24	.22	1.25	.13	.11	.13	.13	.98	.19	.30
Al2O3	18.63	17.04	18.39	14.23	18.33	17.06	14.03	14.06	1.11	1.56	2.36	1.26	15.30	10.96	10.79
Fe2O3	1.31	1.09	1.35	1.08	1.52	.76	1.10	2.37	13.43	13.74	9.06	13.46	2.01	1.52	1.09
FeO	5.35	5.83	4.85	6.15	5.27	3.94	6.07	10.22	1.81	1.72	1.95	4.08	8.96	4.61	7.65
MnO	.11	.45	.12	.13	.11	.09	.14	.20	.18	.19	.19	.16	.16	.33	.17
MgO	7.94	14.90	7.89	10.84	8.53	9.58	11.15	7.77	33.93	33.79	35.22	33.14	8.49	20.20	14.73
CaO	12.52	-	13.26	12.28	12.18	13.20	12.41	13.22	.11	.03	.35	.10	10.21	.15	10.15
Na2O	2.03	.30	1.59	.99	1.86	1.75	1.57	1.56	.05	.02	.03	.01	2.19	.18	.97
K2O	.11	9.28	.08	.06	.04	1.13	.08	.16	-	-	.00	.00	.68	8.58	.33
P2O5	-	-	-	-	-	-	-	.01	.01	.01	.01	.00	.06	.11	.00
LOI	3.57	5.02	4.01	4.64	4.66	4.45	2.44	3.32	11.21	11.15	12.06	10.96	3.24	4.78	3.90
Rest	.21	2.26	.19	.18	.24	.36	.27	.41	.95	1.04	1.29	.90	.32	4.58	.38
Total	100.01	98.47	100.16	100.17	100.17	100.00	100.07	100.41	100.30	100.18	100.09	100.42	100.06	100.38	100.15

Trace elements in parts per million

Ba	57	8	17	13	94	373	56	5	44	12	36	19	114	30	22
Li	-	-	-	-	-	63	22	57	2	2	4	1	102	4245	382
Rb	34	15577	5	4	1	60	4	8	1	1	1	1	109	25350	362
Sr	497	165	372	185	374	373	257	127	11	3	14	15	120	272	188
Pb	2	<2	<2	3	3	5	2	2	<2	<2	<2	3	2	<2	3
Th	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	3
U	<.50	<.50	<.50	<.50	1.00	<.50	.50	<.50	<.50	1.00	<.50	<.50	<.50	<.50	.50
Zr	5	<1	4	7	4	9	8	9	4	2	2	7	50	1	9
Nb	<2	148	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	2	9	<2
Y	4	<1	5	5	4	7	6	18	1	1	2	2	22	267	14
La	<2	<2	<2	2	2	2	2	2	<2	<2	2	<2	6	2	<2
Ce	<5	23	9	<5	<5	<5	5	<5	<5	5	<5	<5	10	34	5
Nd	<2	2	3	<2	2	4	3	<2	<2	3	<2	<2	4	4	<2
Sc	34	1	36	43	35	34	40	54	6	8	5	5	41	3	42
V	112	27	120	145	124	114	136	460	57	60	65	29	308	47	163
Cr	457	1362	91	143	625	882	425	286	4137	4763	5243	3925	383	3241	754
Ni	213	831	85	74	180	293	219	185	2223	2400	3579	2037	218	2037	338
Cu	86	9	44	81	70	212	83	284	16	13	6	8	168	6	109
Zn	47	1497	53	57	54	38	67	99	107	96	112	59	90	304	70
Ga	16	124	18	12	15	13	16	21	6	2	5	3	12	138	6
As	1.00	.50	<.50	<.50	<.50	<.50	1.00	1.00	1.50	1.50	2.00	1.00	2.50	3.50	1.50
S	50	<10	720	740	220	270	830	1700	310	40	280	490	710	160	150

Sample	88330186	88330187	88330188	88330189	88330190	88330191	88330192	88330193	88330194	88330195	88330196	88330197	88330198	88330199a	88330199b
Rock	anortho-site	anortho-site	peridotite	peridotite	peridotite	peridotite	anortho-site	peridotite	lherzolite	peridotite	norite	norite	perid	norite	clinopyro-xenite
SiO2	47.38	48.95	37.27	36.31	37.03	37.61	42.70	38.34	41.43	37.38	52.91	49.87	39.60	53.17	51.92
TiO2	.12	.15	.09	.09	.17	.10	.10	.10	.16	.10	.41	.21	.16	.48	.29
Al2O3	23.57	24.02	3.70	2.65	2.02	.95	17.88	.80	2.55	1.18	14.56	14.64	3.52	12.16	4.57
Fe2O3	.95	.61	9.19	10.98	12.89	13.37	.92	12.07	11.07	13.49	1.29	1.04	5.98	1.15	1.38
FeO	3.34	1.80	2.52	1.71	2.74	1.51	5.48	3.33	3.85	2.96	6.99	5.30	6.59	8.41	5.23
MnO	.06	.04	.15	.14	.22	.12	.10	.15	.17	.19	.14	.11	.19	.16	.15
MgO	5.39	3.59	34.18	34.68	32.74	34.14	12.84	33.53	27.21	32.55	7.47	12.80	31.20	10.35	17.22
CaO	12.78	14.65	.29	.08	.27	.08	12.38	.03	4.11	.27	10.86	11.08	1.71	8.92	14.96
Na2O	2.28	2.47	.03	.02	.03	-	2.12	.02	.21	.03	2.03	1.21	.07	1.77	1.10
K2O	.21	.09	.01	-	.01	.01	.96	-	.01	.00	.50	.22	.00	.23	.04
P2O5	-	-	-	-	.01	.01	-	-	-	.02	.04	.01	.00	.04	.03
LOI	3.89	3.63	11.79	12.31	11.32	11.56	3.74	11.35	8.80	11.43	2.57	2.93	10.47	2.71	2.75
Rest	.29	.26	.65	.70	.62	.53	.46	.38	.43	.53	.26	.38	.43	.36	.36
Total	100.26	100.26	99.87	99.67	100.07	99.99	99.68	100.10	100.00	100.13	100.03	99.80	99.92	99.91	100.00

Trace elements in parts per million

Ba	54	30	48	9	26	110	533	<4	11	24	251	60	<4	155	36
Li	410	250	4	15	3	3	811	4	7	4	44	58	5	41	23
Rb	95	48	1	1	1	1	183	1	1	1	41	40	1	39	<1
Sr	444	455	16	6	14	21	372	5	21	13	158	243	16	91	47
Pb	3	3	<2	2	<2	<2	3	2	<2	<2	5	2	<2	7	2
Th	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	2	<2	<2	2	<2
U	<.50	.50	.50	<.50	.50	.50	<.50	1.00	.50	.50	1.00	.50	.50	<.50	.50
Zr	3	5	2	3	5	5	5	3	5	4	52	8	6	56	30
Nb	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	2	<2	<2	2	<2
Y	4	3	1	2	2	2	6	2	4	2	14	6	4	16	16
La	2	3	<2	<2	<2	<2	<2	<2	2	4	10	4	<2	7	9
Ce	5	5	<5	<5	<5	<5	10	<5	<5	<5	16	7	<5	19	25
Nd	<2	3	<2	<2	<2	<2	2	<2	<2	<2	10	5	<2	6	10
Sc	20	26	6	3	10	7	18	9	17	7	36	28	9	35	57
V	51	77	38	34	58	39	43	39	47	38	182	98	50	198	180
Cr	580	740	2362	2680	2339	1700	325	1244	1179	1153	338	1156	1343	1039	1552
Ni	152	61	2038	2161	1483	1758	621	1261	1563	1814	102	281	1544	189	356
Cu	30	5	7	12	10	7	35	15	5	10	91	66	4	68	40
Zn	29	17	67	86	100	61	54	97	119	121	72	58	119	83	69
Ga	16	17	4	3	1	3	<1	<1	<1	7	23	20	4	14	7
As	5.00	<.50	9.00	<.50	1.50	3.00	2.00	4.00	4.50	4.00	5.00	2.00	.50	2.00	1.00
S	40	20	160	100	530	250	110	90	250	940	620	740	60	680	30

Sample	88330200	88330201	88330202	88330203	88330204	88330205	88330206	88330207	88330208	88330209	88330210	88330211	88330212	88330213
Rock	peridotite	websterite	websterite	peridotite	websterite	websterite	gabbro	peridotite	orthopyro-xenite	orthopyro-xenite	orthopyro-xenite	websterite	lherzolite	clinopyro-xenite
SiO2	40.04	51.34	48.44	38.96	52.96	52.23	46.98	37.84	49.50	52.87	52.19	48.31	40.76	51.68
TiO2	.11	.37	.41	.07	.28	.34	.16	.09	.22	.17	.16	.40	.32	.36
Al2O3	1.38	5.77	5.74	1.88	6.51	10.35	15.99	2.19	5.23	2.96	2.30	12.08	7.19	2.65
Fe2O3	4.96	1.00	3.71	7.12	1.39	1.15	1.13	10.07	1.33	1.93	2.36	1.27	2.48	1.63
FeO	7.01	7.77	5.40	5.95	7.78	7.60	4.23	3.16	7.41	6.01	5.93	7.81	9.46	8.27
MnO	.19	.17	.17	.13	.16	.15	.11	.17	.15	.17	.16	.17	.15	.21
MgO	33.96	18.16	20.53	33.33	19.90	14.05	10.93	34.12	24.38	27.74	29.53	11.86	25.15	17.56
CaO	.21	10.24	9.91	.08	3.92	6.64	13.82	.07	3.49	2.51	1.96	12.31	4.60	15.20
Na2O	-	.84	.59	.02	.71	1.96	1.07	.02	.13	.17	.08	.90	.15	.45
K2O	-	.13	.04	-	.54	.33	1.07	-	.94	.15	.01	.74	.02	.04
P2O5	-	.01	-	-	.02	.03	-	-	.01	.00	.00	.00	.01	.01
LOI	11.60	3.69	4.12	11.83	5.04	4.49	3.94	11.60	6.23	4.65	4.34	3.84	9.01	1.38
Rest	.55	.31	.67	.67	.64	.45	.50	.59	.87	.85	.93	.32	.65	.49
Total	100.01	99.80	99.73	100.04	99.85	99.77	99.93	99.92	99.89	100.18	99.95	100.01	99.95	99.93

Trace elements in parts per million

Ba	<4	61	48	113	192	160	407	13	74	41	<4	591	5	<4
Li	6	70	13	5	105	139	185	7	130	11	13	72	8	12
Rb	1	26	3	1	197	76	260	1	410	15	2	48	3	1
Sr	4	86	82	8	148	110	1177	8	33	84	3	164	6	43
Pb	<2	3	2	<2	2	4	2	<2	4	<2	2	7	<2	<2
Th	<2	<2	<2	<2	2	2	<2	<2	3	<2	2	<2	<2	<2
U	<.50	<.50	<.50	<.50	.50	1.00	<.50	<.50	1.00	<.50	<.50	.50	<.50	<.50
Zr	4	14	14	2	38	47	3	1	27	11	11	9	10	13
Nb	<2	<2	<2	<2	2	2	<2	<2	2	<2	<2	<2	<2	<2
Y	2	13	12	1	12	13	10	1	14	3	3	8	7	12
La	<2	4	<2	<2	8	8	<2	<2	4	2	2	2	<2	<2
Ce	<5	10	9	<5	12	16	13	<5	8	<5	7	<5	<5	<5
Nd	<2	8	8	<2	6	8	3	<2	5	<2	<2	<2	<2	4
Sc	9	42	45	3	24	28	37	7	18	16	17	43	18	68
V	42	136	174	34	134	154	113	35	98	81	84	136	122	212
Cr	1935	1005	3091	2490	3001	1893	860	2200	4334	5027	5665	769	2779	833
Ni	1735	566	678	2082	470	340	406	1712	782	505	517	199	1513	223
Cu	3	7	354	53	63	53	160	5	24	21	15	174	93	211
Zn	138	106	76	82	76	74	41	120	64	58	59	69	72	76
Ga	2	7	7	5	12	16	13	2	6	4	3	12	5	2
As	.50	<.50	1.00	1.50	1.00	.50	<.50	1.50	<.50	.50	<.50	<.50	.50	.50
S	210	<10	120	50	40	10	170	260	160	<10	<10	60	<10	2470

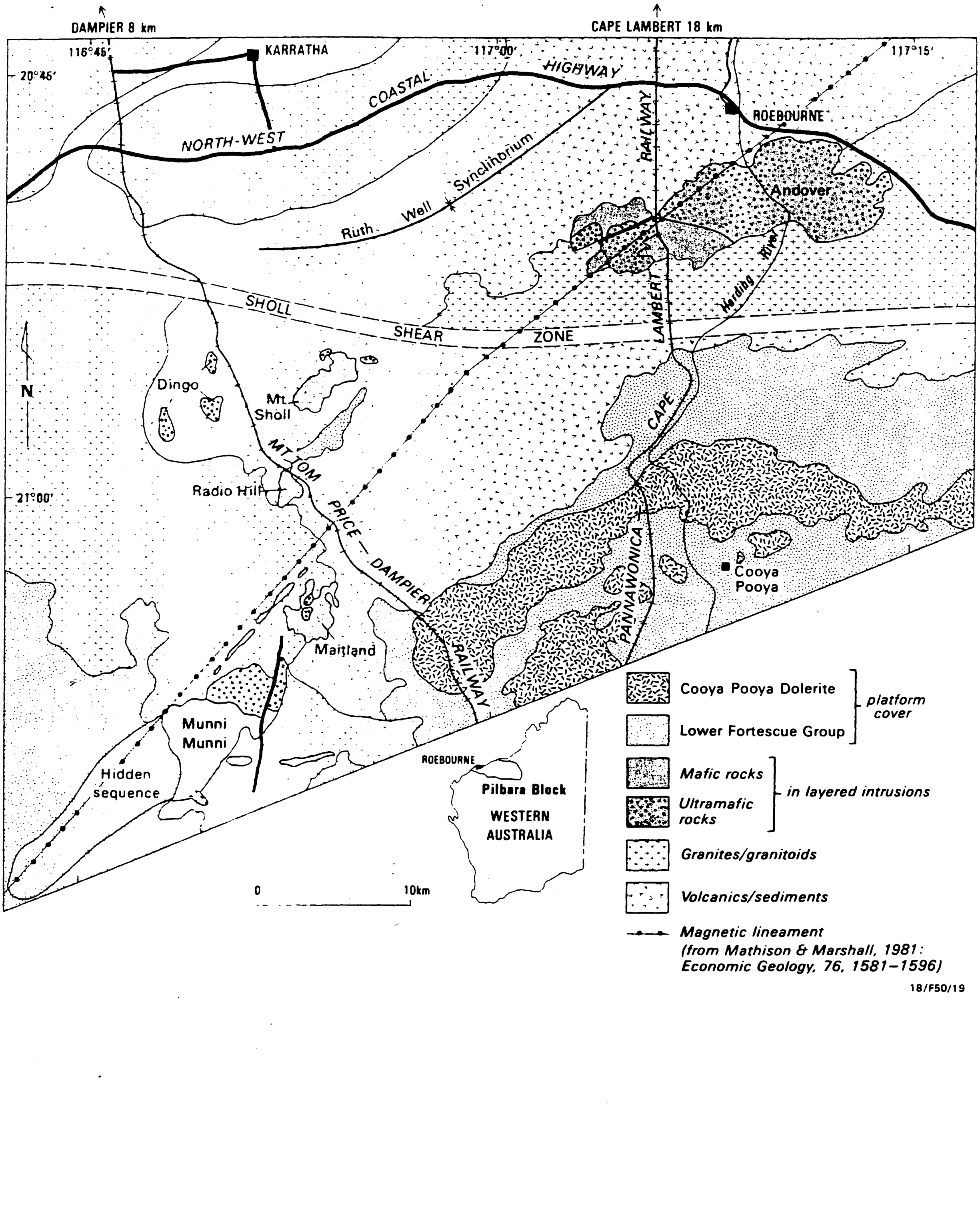

Figure 1. West Pilbara mafic-ultramafic rock units.

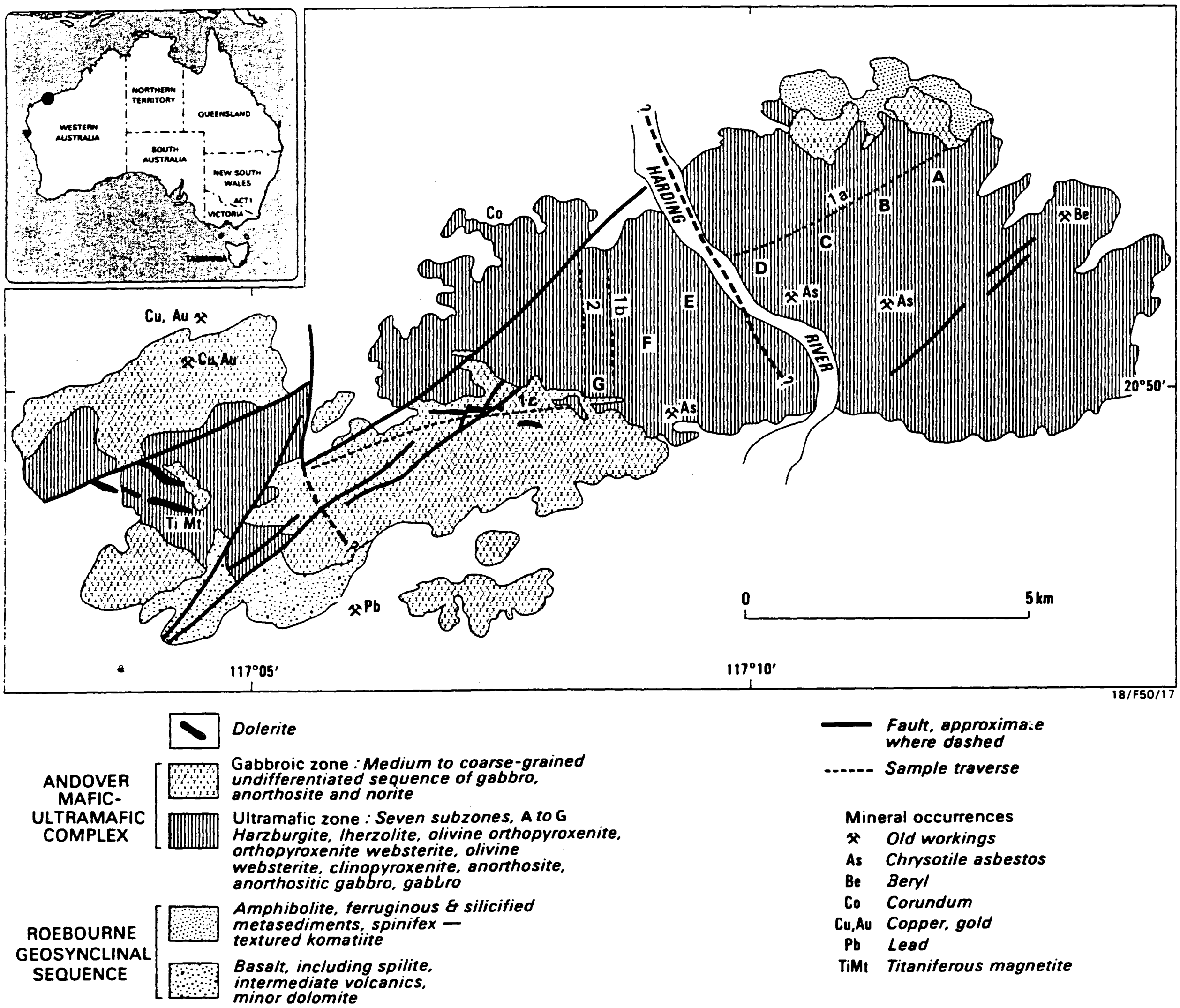

Figure 2. Andover Complex – geology, mineral occurrences, old mineral workings. Sample traverses are indicated by broken line.