COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS

RECORDS:

1965/72

REGIONAL GEOCHEMICAL SAMPLING METHODS USED BY THE BUREAU OF MINERAL RESOURCES

by

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SUMMARY

Regional Geochemical sampling is gaining widespread popularity in many countries as an integral part of any prospecting programme for metalliferous deposits. Techniques used, in this type of investigation, by the Bureau of Mineral Resources are described at length in this Record as a guide to the geologist supervising geochemical sampling programmes.

Procedures for recording of data related to samples, are also set down. These data are integrated with the recording and retrieval system currently in use in the Bureau.

INTRODUCTION

Regional geochemical reconnaissance methods are rapidly gaining a prominent position in regional exploration programmes being carried out by the major geological surveys. This regional approach has been a permanent feature of the Russian exploration programmes for many years and more recently the method has been applied with considerable success in the U.S.A., Canada and Africa. Since 1947 the Bureau of Mineral Resources has carried out a number of detailed geochemical soil surveys and more recently has extended these investigations to sediment surveys for the purpose of regional exploration. The Bureau has now introduced regional geochemical surveys as an integral part of the field mapping programme.

The aim of a regional geochemical survey is to aid in appraising the mineral potential of a region by determining the broad pattern of metal distribution and thereby defining areas of potential economic interest within the region. Briefly, geochemical prospecting is based on the fact that soils and stream sediments adjacent to, and some distance from, a mineralized area can be enriched in metal content by dispersion from the mineralization. This dispersion results from the migration of metal ions in ground water and by downslope movement of the overlying metal-rich soils which eventually reach the drainage. Thus analyses of soil and stream sediment can show up areas of anomalous high metal content which may be related to centres of mineralization. This method of prospecting is of particular value where mineral deposits cannot be observed directly owing to thick soil cover and deep weathering. Heavy detrital minerals are also very useful in geochemical prospecting because they commonly form long and distinct dispersion trains in drainage channels. These may contain economic minerals which can be detected by the analysis and mineralogical examination of panned concentrates or may contain trace elements which are genetically connected with mineralization. In the geological mapping of deeply weathered rocks these detrital heavy minerals can often be used for the identification of the country rock. They can also indicate the grade of metamorphism. Systematic sampling and analysis of igneous and metamorphic rocks and some of their minerals is another important aspect of regional geochemical appraisal. Regional high metal values in these rocks or component minerals may indicate geochemical and metallogenetic provinces.

The following are basic instructions for the collection of geochemical samples. The supervising geologist should refer to Hawkes and Webb* for a more comprehensive account of sampling techniques and theoretical considerations.

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* Hawkes H. and Webb J.S. (1962) 'Geochemistry in Mineral Exploration'.

COLLECTION OF SAMPLES

Instructions for the routine collection of samples in the proposed programme are given below.

In selected areas field assistants, under the general supervision of geologists, will collect stream sediments and heavy mineral concentrates in the following way.

Stream Sediments

Active (stream bed) sediments from drainage channels (wet or dry) at, ideally, intervals of about one mile.* The samples should be restricted to tributaries and should not be taken from trunk rivers and large creeks where metal-rich soil washed into the drainage would immediately be diluted to background values by the river's large load of barren sediment. It is very difficult to define thelimits of a basin in which one would expect anomalous metal values to persist. This depends very much on the chemical properties of the elements concerned, the extent of mineralization, degree of active erosion, size of stream, rock type over which stream is passing, etc. However, as a generalisation, one can say that the length of a detectable train of anomalous values downstream from a significant deposit is commonly found to lie between 1000 ft and 2 miles. The size of the largest stream, conveniently expressed as the maximum area of the catchment basin in which such an anomaly may be detectable, is between 5 and 20 square miles. It is important, then, that sediment should be collected in the upper 10 square miles of a drainage basin and downstream from this area samples should only be collected from the valley slope soils and from small streams leading into the main trunk stream.

These active sediment samples should be collected as far up the tributary streams as is necessary to avoid backwash from the trunk drainage. Samples should be taken from the stream bed at the centre of the channel by means of an 80-mesh sediment sampling sieve. Alternatively but less satisfactorily, fine samples may be collected in quiescent eddies of the stream. It is important to obtain a sample which represents a mixture of the colluvial material donated to the stream from both valley slopes and not from locally derived soil that has slumped in from one bank only. Sufficient sample should be collected to quarter fill a sample bag. If coarse resistant minerals (e.g. beryl or columbite from pegmatite, cassiterite from greisen etc) are known or suspected to occur in the area, a coarser fraction (say minus 28 mesh) should be collected for analysis.

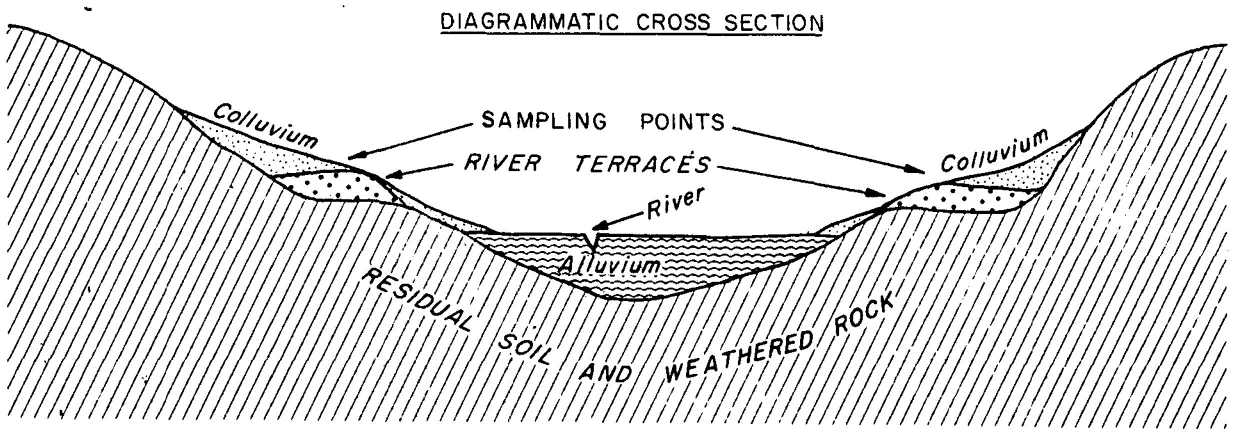
A form corresponding to the 'master' punch card in the geochemical data processing system is stamped on the geochemical sample bags. A full description of the sample should be recorded on this form (use a ball pen or, better still, a Pental pen) and should be completed according to the code in Appendix V.

Valley slope colluvium

In the lower parts of minor drainage basins and also in valleys bordering major streams and rivers, colluvial soil samples should be collected from the lower parts of the valley slopes. Here stream sediments are of little value, and the sheetwash material should be sampled before it enters the stream. These samples, although widely spaced and not representing such a large part of the drainage basin as the stream sediments, could pick up metal values from dispersion fans radiating from mineralization upslope. In steep topography the fans would be narrow and less likely to be detected by widely spaced samples.

* It should be noted that this density of sampling is designed to outline geochemical provinces in which more detailed sediment surveys may be carried out at a later date. For detailed surveys a density of 5 to 20 or more per square mile would be required. A map showing a typical pattern of drainage samples collected in regional geochemical reconnaissance is shown in Appendix IV.

The sample is collected from the near surface (say 2 ins in depth) a short distance up the valley slopes, and should consist of the colluvial soil being donated by sheetwash to the active sediments. The samples should be collected above the stream flood level and, if possible, material from old river terraces should be avoided.



Bureau Of Mineral Resources, Geology & Geophysics May, 1964 To Accompany Record Nº 1964/57 M(M)/62

Country Rock Samples

Rock samples should, where possible, be collected at or near the same site as rock specimens collected for petrological examination. They should represent all rock types in the area, the density of sampling on any one rock type being related to its homogeneity and to its importance as a possible parent or host for mineralization. A rock of heterogenous composition may require a number of discrete samples over a small area or may require a composite of these samples. With homogeneous rocks a fragment broken from the petrological specimen may suffice. The sample location and description of the rock type should be recorded on the form printed on the sample packet. Any special features such as the likely presence of economic minerals should be noted on the general submission form (Appendix VI).

Mineralized Rock Samples

Samples should be collected from all or at least outcrops representing local mineralization. If possible these should take the form of channel samples across the mineralization. In the case of fissure type deposits the channel should also pass into the foot and hanging walls for distances up to 200 ft. Composited chip samples should be collected over sections of 1 to 5 ft. in the mineralized rock and over 5 to 20 ft. in the adjoining walls. This should provide important information concerning the range of trace elements present, their primary dispersion in rock and the mineralogical relationships. Samples of between 1 and 2 lbs. should be submitted uncrushed and in plastic sample bags in which the geochemical sample bag with completed form has been inserted. Samples such as these are usually only obtainable in working mines or perhaps in old mining or prospecting open-cuts. Often the only visible sign of mineralization may be a gossan capping or mullock or slime heaps. These can be an important source of information concerning the range of trace elements associated with the deposit and should be sampled and submitted for comprehensive trace element analysis.

Heavy mineral concentrates

Heavy mineral concentrates should be collected from the lower reaches of subsidiary drainage basins in those areas in which columbite, cassiterite, wolframite, chromite, pyrochlore, monazite, zircon,ilmenite, rutile, gold or any other heavy resistant economic minerals could occur. These concentrates should be collected if possible from a gravel bar or riffles in the stream bed. The sampler should reject pebbles and cobbles and pan remaining material having a medial diameter of coarse sand. Preliminary grading may be carried out by means of a 1/16" iron gauze sieve. A single heaped 12 in. pan of gravel (approx. 10 kg.) should provide sufficient concentrate (20 to 100 g.) for analysis and mineralogical examination. The concentrate should be panned to a grey fraction (do not pan to a black fraction) and placed in a sample packet. Where water is not available in streams, the sieved gravel should be put in cotton or plastic bags and brought back to base camp for panning. Details should be recorded according to the code in Appendix V.

LOCATION OF SAMPLES

Sample localities should be recorded by pricking the localities on aerial photographs and writing the sample number on the back. These localities should then be located on photo scale compilation maps (transparent) on which the National grid has been superimposed. The position of the sample as easting and northing coordinates is read off and recorded on the sample bag.

CONTAMINATION

Contamination of soil and stream sediments may occur in areas of disturbed ground, old mine workings and dumps, roasting or smelting furnaces, and near towns. Possibility of any such contamination should be noted on the sample packet and on the locality map. Care should be taken to ensure that samples are not contaminated by paint, tin or tinned iron, solder etc., on makeshift sampling vessels, and subsequently by containers carrying the sample packets. Avoid the use of galvanised or soldered containers. It is preferable to transport the dry sample packets in cardboard boxes or in polythene bags. Geological hammers, shovels etc. are often painted with a metal-rich paint. This should be removed with a file or emery cloth. Always wrap up rock specimens being submitted for trace element analysis; rolling around on the floor of a Land Rover can cause contamination by paint (at least!).

ORIENTATION SURVEYS

Without orientation surveys it would be impossible to design a comprehensive sampling programme and scheme of sample analysis that would be applicable to the wide variety of rocks and the great diversity of geological associations that occur in Australia.

It is preferable that data from an orientation survey is available before a regional geochemical survey is commenced so that sampling density, type of sample required and methods of sampling can be worked out for each area. It is not always possible to carry out the orientation survey beforehand and it may be necessary to do this at the same time as the regional survey. In this case regional sampling methods must follow a standard pattern until orientation data is available.

Information concerning the range of elements associated with the country and mineralized rocks is a first essential. The sampling of this material is dealt with in previous sections. Also of primary importance is information on the extent of dispersion of these elements in the drainage below mineralization. If undisturbed mineralization is known, detailed sediment sampling in the drainage downstream may indicate how far the indicator element has migrated and what would be the optimum sampling distance to locate similar dispersion trains elsewhere. Sieve sizing and mineralogical studies can give a great deal of information concerning the distribution of significant elements in the various components of the sediment.

Mineralogical examination of heavy mineral concentrates and analysis of components is also important in this preliminary study to see if any suite of heavy minerals is associated with mineralization and if any of these minerals have a characteristic trace element assemblage genetically related to mineralization.

Trace element content of igneous and metamorphic rocks and some of their mineral components (e.g. biotite, sulphide, magnetite etc) may be important and initial sample collecting should be made in the vicinity of known ore deposits.

Soil samples should also be collected over mineralization or over the projected extension. Soil profiles down to weathered rock, if possible, should be sampled in detail at close interval sample points. This data will provide a picture of the vertical and lateral distribution of trace elements in the soil profile, possibly reflecting the secondary dispersion pattern, and the distribution of trace elements in size fractions and mineral components of the soil.

This is an outline only, of the orientation phase in regional geochemical reconnaissance. Sample collection in this type of survey requires a geologist with a very strong geochemical background. Many factors are involved in the primary and secondary distribution of trace elements and the geologist should be aware of these in the selection of critical samples.

INTERPRETATION

As a guide to the selection of elements for analysis of rocks, sediment, soil and concentrates, lists are given in Appendices I and II indicating trace element associations with the common rock types and with various types of mineralization. A list is also given of elements related to those economic minerals which could be expected to occur in heavy mineral concentrates.

These elements should be selected according to country rock and possible mineralization. Appendix III will give some idea of the trace element content of various igneous and sedimentary rock types. There is, of course, a great deal of variation in trace element content within each rock type and from one region to another, and it is likely that many of the average values shown will not be related to the values found during regional reconnaissance. The list, however, will give some idea of the quantity of each element that may be expected in the various rock types, and will assist to some extent in preliminary interpretation.

SUBMISSION OF SAMPLES

Before the commencement of the field season each geologist supervising the sampling should discuss the programme and analytical requests with his supervising geologist, party leader and members of the geochemical section. After the field season, interpretation of the analytical results should be discussed with the above persons.

All samples should be addressed to the Chief Geologist enclosing a standard sample submission form on which only the 1st, 2nd, 4th and 5th lines need to be filled in.

The monthly report should

(a) State clearly number of samples collected and date of despatch of each batch.

(b) Include sketch map showing area sampled.

Sample numbers will be stamped on the packets by means of an automatic enumerator. To facilitate read out for the punch card operator it would be appreciated if the eight digits stamped in the box titled 'Registered Number' are positioned exactly under box numbers 3 to 10. (See Appendix V). These packets, which are designed to carry wet samples, have high wet strength and waterproof glue, but care is still needed in transporting the bags from the sample site. They may be dried in the sun without opening. The tops should be turned over twice to prevent loss of sample in transit. A special sample box has been designed for the transport and storage of geochemical samples. A sufficient supply of these boxes should be taken with the field party at the beginning of the season.

Samples should be collected in numberical sequence. However it would be helpful if the samples are submitted by segregating different types of material. Details of samples, their numbers etc., should be entered into the sampler's field note book in the usual manner.

Geochemical samples should be air freighted back to Canberra at regular weekly intervals during the field season. In this way the analytical laboratory will be sure of receiving a steady flow rather than a great wave of samples every November!

APPENDIX 1

TRACE ELEMENT ASSOCIATION WITH COMMON ROCK TYPES

IGNEOUS ROCKS	ELEMENTS OF IMPORTANT MINERALS DEPOSITED BY MAGMATIC EMANATION	ELEMENTS OF IMPORTANT MINERALS DEPOSITED BY MAGMATIC CONCENTRATION
GRANITE	Mo As Bi Sn Cu Au W Zn Pb Te U Ag Sb Hg Li Sr Ba F B Th Be Na K	
Pegmatite	F Bi W Sn Cu Mo Li P Nb Ta Be Cs Rb B La Th U	
GRANODIORITE	As Au Cu Zn Pb Ag Sb Hg Sn Mo W Bi Li Na K	
Pegmatite	Mo W B	
ALK. SYENITE & NEPHELINE SYENITE	Au Cu Zn Nb Sr Ba Zr Na K	Fe Ti (Pyroxenite)
Pegmatite	P Zr Cs Rb B La Th	
QUARTZ DIORITE	Fe As Au Zn Cu Ag Pb Li	
SYENITE & QUARTZ SYENITE	Mo P Zn	
MONZONITE & DIORITE	As Cu Au Mo (Porphyry)	Ti Fe P
(Andesite)	Au As	
NORITE		Cu Ni Cr Pt Pd Co V
GABBRO		Fe Ti P Cu Co Ni V
PERIDOTITE		Pt Cr Ni Co
ANORTHOSITE		Ti Fe
PYROXENITE		Ni Cu Ti Fe

APPENDIX II

ELEMENTS OF IMPORTANT MINERALS IN MINERAL DEPOSITS

A.	Contact metasomatic deposits	Fe Cu Zn Pb Sn W Mo Mn As Au Pt B F Be Hg U
B.	Hydrothermal processes	
	1. Cavity filling	Au Ag Pb Cu Zn Sn Sb Co Hg Mo Ra U W F Ba Bi Se Hg K Sr Cd
	2. Metasomatic replacement	Fe Cu Pb Zn Au Ag Sn Hg Mo Mn Ba F Sr K
C.	Specific Associations	
	1. Limestone replacement	Zn Pb Ba F Sr W
	2. Complex base metal	Zn Pb Ag Cu Se Sb Bi
	3. Simple precious metal	Ag Au As
	4. Complex precious metal	Ag Au As Sb Zn Cu Pb Hg Te
	5. Ores associated with mafic igneous rocks	Ni Co Pt Cr
	6. Porphyry copper	Cu Mo Re

TRACE ELEMENT ASSEMBLAGES IN SOME SEDIMENTARY ROCKS

Iron oxides	Cr Ni As Co V Se Ge Ba
Manganese oxides	Mo Co Ni Zn Ba V As W Li Cu Pb P (Ra Th Tl)
Phosphorite	Ag Mo Pb F U
Black Shale	Ag Mo As Bi Cd Sb Au Mo Pb V Zn U Cu

Elements of important minerals in detrital heavy mineral concentrates

Nb Ta Sn W Cr Th Zr Ti Au V (Zn & Cu associated with magnetite)

APPENDIX III

DISTRUBUTION OF SOME ELEMENTS IN THE EARTH'S CRUST** (PARTS PER MILLION)

	IGNEOUS ROCKS					SEDIMENTARY ROCKS		
	Ultra-basic	Basaltic	Granitic High Ca.	Granitic Low Ca.	Syenites	Shales	Sstns.	Carbon-ates.
Lithium	0.X	17	24	40	28	66	15	5
Beryllium	0.X	1	2	3	1	3	0.X.	0.X
Boron	3	5	9	10	9	100	35	20
Fluorine	100	400	520	850	1200	740	270	330
Sodium	0.42*	1.8*	2.84*	2.58*	4.04*	0.96*	0.33*	0.04*
Magnesium	20.4*	4.6*	0.94*	0.16*	0.58*	1.5*	0.7*	4.7*
Aluminium	2.0*	7.8*	8.2*	7.2*	8.8*	8.0*	2.5*	0.4*
Silicon	20.5*	23.*	31.4*	34.7*	29.1*	7.3	36.8*	24.0*
Phosphorus	220	1100	820	600	800	700	170	400
Potassium	40	0.83*	2.52*	4.2*	4.8*	2.66*	1.07*	0.27*
Calcium	2.5*	7.6*	2.53*	0.51*	1.8*	2.21*	3.91*	30.23*
Scandium	15	30	14	7	3	13	1	1
Titanium	0.03*	1.38*	0.34*	0.12*	0.35*	0.46*	0.15*	0.04*
Vanadium	40	250	88	44	30	130	20	20
Chromium	1600	170	22	4.1	2	90	35	11
Manganese	1620	1500	540	390	850	850	X0	1100
Iron	9.43*	8.65*	2.96*	1.42*	3.67*	4.72*	0.98*	0.33*
Cobalt	150	48	7	1	1	19	0.3	0.1
Nickel	2000	130	15	4.5	4	68	2	20
Copper	10	87	30	10	5	45	X	4
Zinc	50	105	60	39	130	95	16	20
Gallium	1.5	17	17	17	30	19	12	4
Germanium	1.5	1.3	1.3	1.3	1	1.6	0.8	0.2
Arsenic	1	2	1.9	1.5	1.4	13	1	1
Selenium	0.05	0.05	0.05	0.05	0.05	0.6	0.05	0.08
Rubidium	0.2	30	110	170	110	140	60	3
Strontium	1	465	440	100	200	300	20	610
Yttrium	0.X	21	35	40	20	26	40	30
Zirconium	45	140	140	175	500	160	220	19
Niobium	16	19	20	21	35	11	0.0X	0.3
Molybdenum	0.3	1.5	1.0	1.3	0.6	2.6	0.2	0.4
Silver	0.06	0.11	0.051	0.037	0.0X	0.07	0.0X	0.0X
Cadmium	0.X	0.22	0.13	0.13	0.13	0.03	0.0X	0.035
Indium	0.01	0.22	0.0x	0.26	0.0X	0.1	0.0X	0.0X
Tin	0.5	1.5	1.5	3	X	6.0	0.X	0.X
Antimony	0.1	0.2	0.2	0.2	0.X	1.5	0.0X	0.2
Cesium	0.X	1.1	2	4	0.6	5	0.X	0.X
Barium	0.4	330	420	840	1600	580	X0	10
Lanthanum	0.X	15	45	55	70	92	30	X
Cerium	0.X	48	81	92	161	59	92	11.5
Tantalum	1	1.1	3.6	4.2	2.1	0.8	0.0X	0.0X
Tungsten	0.77	0.7	1.3	2.2	1.3	1.8	1.6	0.6
Mercury	0.0X	0.09	0.08	0.08	0.0X	0.4	0.03	0.04
Thallium	0.06	0.21	0.72	2.3	1.4	1.4	0.82	0.0X
Lead	1	6	15	19	12	20	7	9
Bismuth	[illegible]	0.007	?	0.01	?	?	?	?
Thorium	0.004	4	8.5	17	13	12	1.7	1.7
Uranium	0.001	1	3	3	3	3.7	0.45	2.2

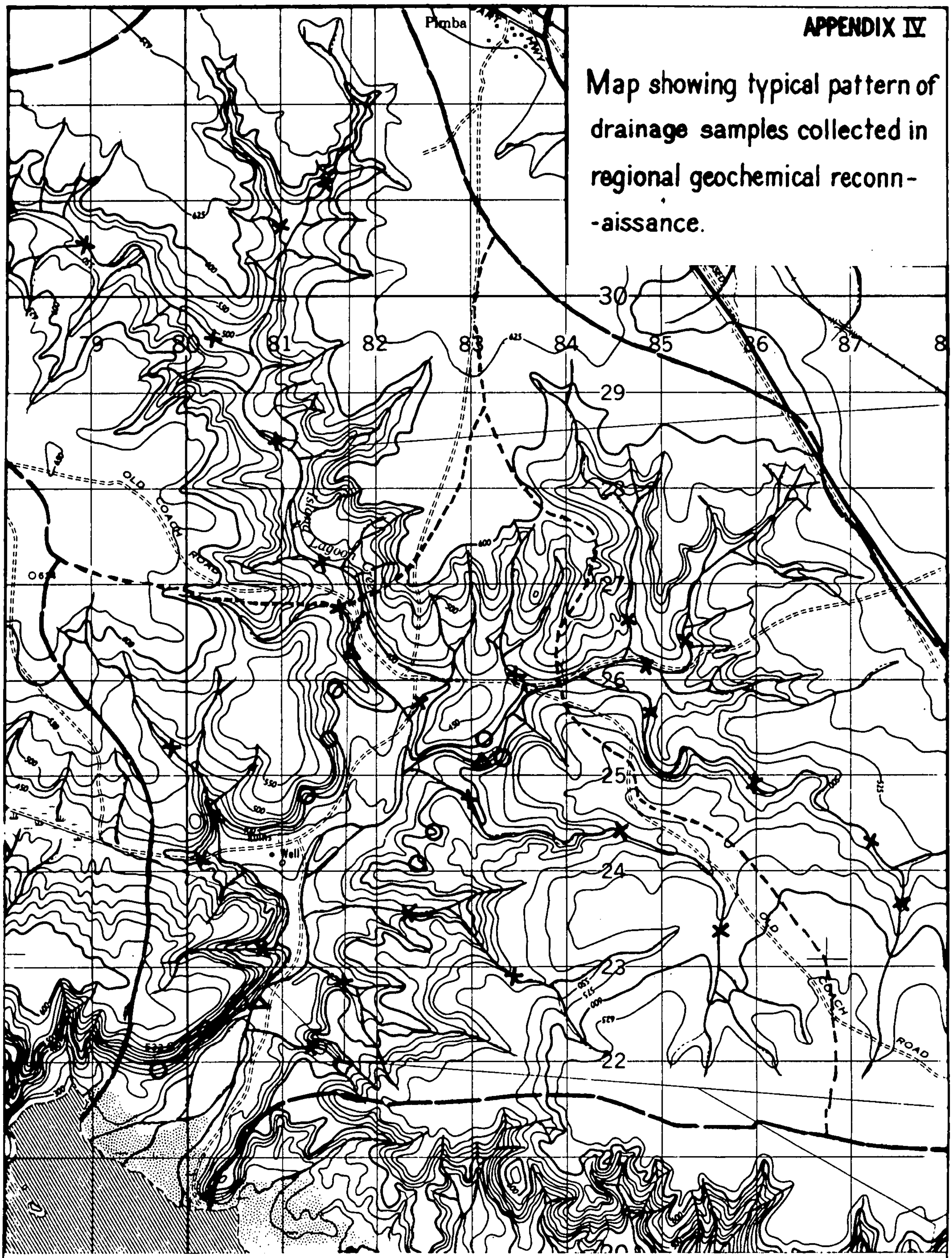
** After Turekian and Wedepohl, Geol.Soc. Amer. Vol.72 1961

* Figures in per cent.

X Order of magnitude

APPENDIX IV

Map showing typical pattern of drainage samples collected in regional geochemical reconn- -aissance.



SCALE

0 ½ 1 2 3 Miles

Watershed of main drainage basin.

Boundary of minor drainage basins, within catchment area, each having an area of approximately 10 square miles. Only sediments are collected from the streams in these areas. Outside the minor basins, colluvial soil samples are collected from the valley slopes, and sediment samples from minor tributaries only.

× *Sediment sample point.*

○ *Colluvial soil sample point (collected at base of valley slopes)*

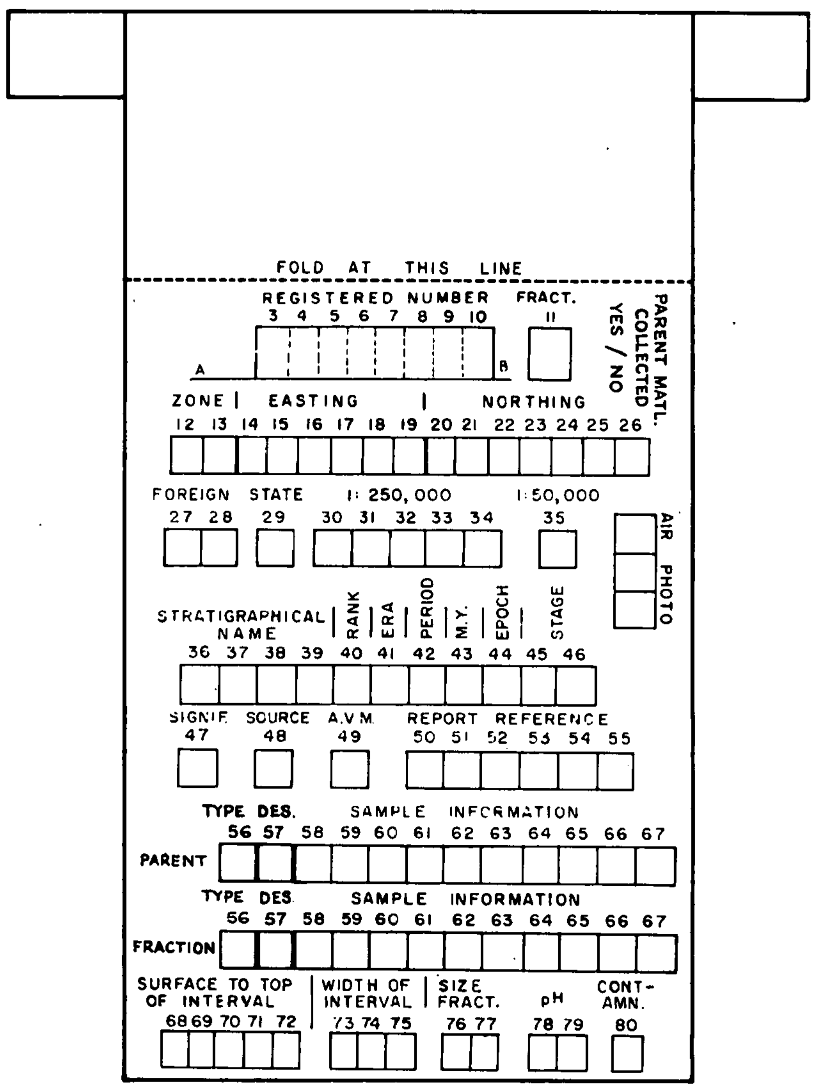
△ *Heavy mineral concentrate (collected at the necks of minor and major drainage basins.)*

Bureau of Mineral Resources, Geology & Geophysics. M(M)/61 G.M.

APPENDIX V

CODE FOR REGISTERING GEOCHEMICAL DATA

CONTENTS



FOLD AT THIS LINE

REGISTERED NUMBER 3 4 5 6 7 8 9 10 — FRACT. 11 — PARENT MATL. COLLECTED YES / NO

A B

ZONE | EASTING | NORTHING
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

FOREIGN 27 28 — STATE 29 — 1: 250,000 30 31 32 33 34 — 1:50,000 35 — AIR PHOTO

STRATIGRAPHICAL NAME | RANK | ERA | PERIOD | M.Y. | EPOCH | STAGE
36 37 38 39 40 41 42 43 44 45 46

SIGNIF. 47 — SOURCE 48 — A.V.M. 49 — REPORT REFERENCE 50 51 52 53 54 55

PARENT — TYPE DES. 56 57 — SAMPLE INFORMATION 58 59 60 61 62 63 64 65 66 67

FRACTION — TYPE DES. 56 57 — SAMPLE INFORMATION 58 59 60 61 62 63 64 65 66 67

SURFACE TO TOP OF INTERVAL 68 69 70 71 72 | WIDTH OF INTERVAL 73 74 75 | SIZE FRACT. 76 77 — pH 78 79 — CONT-AMN. 80

Geochemical Sample Submission and combined Report Form printed on geochemical sample bags.

APPENDIX V

INSTRUCTIONS FOR THE RECORDING OF GEOCHEMICAL DATA ON SAMPLE BAG FORMS AND FOR THE SUBMISSION OF SAMPLES

A form has been printed on all geochemical sample bags so that data pertinent to the sample may be recorded in the same order as it will be punched on the B.M.R.'s chemical master punch card.

The following code has been designed to assist in the recording of geochemical data and is part of a comprehensive code 'Sample registration, informing storage and retrieval system, Geological Branch, B.M.R.' by Walpole B.P., Haldane A.D., Mather A.L., and Morgan W. B.M.R. Records 1964/139. A number of amendments have been made to the code both in this record and in Record 1964/57 'Regional Geochemical Sampling Methods' by A.L. Mather. For the purpose of coding geochemical samples only, both Records are now superceded by this one.

INSTRUCTIONS FOR THE RECORDING OF DATA ON SAMPLE BAG FORMS

It is very important that these forms are filled in with great care. Incorrectly completed forms will defeat the purpose of the information retrieval system and may cause delay in the analysis of samples.

Boxes 3 to 10 Registered Number

The Registered Number will now be allocated by the Party Leader or non-party originator to all samples submitted for examination or storage in the Museum.

It is an eight digit number of which the first two digits represent the year in which the sample is collected (e.g. this year would be represented by 65).

The second two digits constitute a prefix which will be allocated to each field party or individual collector and which will be obtainable from the Transit Room manager. This prefix will characterise all samples collected in a specific area (e.g. a 1:250,000 Sheet) or for a special project where collecting is scattered. If the party or project carries on into the following year or is expected to be continued in the near future, the same prefix number would be retained for that project. Where more than one geochemical sample grid is to be used in any one area (e.g. the multiple grids at Rum Jungle and Tennant Creek) a prefix number will be allocated for each grid.

The next four digits are the Serial Number which provides for a maximum of 9999 samples for each prefix and year. Should this number be exceeded, a second prefix will be allocated.

An automatic enumerator capable of printing eight digits should be used for the numbering of sample packets. This may be obtained from the B.M.R. store at Canberra. The stamped figures may be accurately centred in the space provided by aligning the two prongs at the base of the enumerator with the register AB on the base line of the Registered Number boxes on the packet.

Box 11 Fraction

This is an extension to the Registered Number and is to be used where a fraction has been separated from a discrete parent material. This enables both the parent material and fraction to have the same Registered Number (essential for the data retrieval equipment) and at the same time permits separate description of parent and fraction (separate master cards in punch card system). Parent material is defined as any consolidated or unconsolidated geological material that has not been artificially fractionated. This includes fresh and weathered rocks, alluvium, stream sediments, soil, beach sands etc. The Fraction, on the other hand, consists of any artificial separate from a geological parent material (e.g. felspar fragments chipped from a pegmatite, heavy mineral concentrates panned from a stream sediment, magnetite removed from soil with a magnet, heavy liquid separation of minerals from rocks etc). Using digits from 1 to 9 and then letters A to Z up to 35 fractions can be recorded for any one sample.

In every case the parent material will be represented by the eight digit Registration Number followed by a zero in the Fraction box. Where the sample is a fraction the question 'parent material collected?' printed to the right of box 11 should be answered by crossing out yes or no.

Boxes 12 to 26 - Grid Reference.

All samples will, in future, be located by means of the Australian Military Grid System or, in the case of the Territory of Papua and New Guinea, by the U.T.M. Grid System. (In a few years time the U.T.M. Grid System will also be used in Australia).

For each sample the Zone should be specified. In the case of the Australian Grid, Australia is divided into eight vertical zones. Each zone is 6° wide and has its own individual grid. The zones are numbered from 1 to 8 and in registering the zone on the form, 0 (zero) should be placed in box 12 followed by the zone number in box 13. For Papua and New Guinea the zones are numbered from 54 to 56 and in this case both boxes 12 and 13 should be used. Where a mine or other arbitrary grid is used, insert the figures 09 in the zone box. Military or U.T.M. grid zone numbers are printed on most topographical maps of 1:250,000 scale or less.

In the location of geochemical samples on Military or Metric grids, easting and northing coordinates should be recorded to the nearest significant digit. Provision for 13 digits can locate samples to the nearest yard or metre (6 digits easting followed by 7 digits northing). However it is sometimes only possible to locate samples to say the nearest 100 or 1000 yds/metres and to indicate the significance of the coordinates a minus sign should be placed in those boxes of the easting and northing that are not significant (e.g. a four figure easting and a five figure northing would be

2	3	2	6	-	-	1	8	2	6	0	-	-

Care should be taken not to omit the first digit of the northing. This is usually indicated in very small type at the lower left corner of the topographical map. South of approximate latitude 26°, northings do not exceed six digits and a zero should be placed in the first northing box.

Geologists should make sure that, before leaving for the field, the military grid has been superimposed on transparent photoscale compilation maps covering their field area. The co-ordinates of any point plotted on an aerial photograph may then be located by laying the maps on the photograph. Reading of the grid coordinates can be greatly facilitated by the use of a Romer, a transparent L shaped scale graduated along the two ordinates of the scale. These Romers can be provided by the drawing office and should match the scale of the photoscale compilations. If photoscale compilations are not available, geologists should locate samples on topographic maps on which the Australian grid has been superimposed. Where samples are being collected on grids not aligned with military grid ordinates, the position of two points on the base line should be given in terms of the arbitrary and military coordinates.* (If the grid is properly surveyed, the surveyor can be requested to provide this information). From these data the military grid references may be obtained for all other points on the grid. Geologists are reminded that the original and selected points on a surveyed base should be marked by star pickets set in concrete. It should also be noted that all grids not aligned with military or metric grids should have a false origin well outside the grid so that all coordinates may be given as eastings and northings and in terms of feet. In these cases easting and northing boxes would be filled

* These references should be recorded on the sample submission form with each batch of samples (See Appendix VI).

in progressively from the right and unused columns on the left would be filled in with zeros. This will greatly facilitate future computations and automatic plotting of results.

Boxes 27 to 28 Foreign Collection

A two-letter alpha-code is used to indicate the country from which the specimens were collected. The usual form will be the first letter and the next consonant. For countries with two or more names, the initial letter of each of the first two words is to be used, e.g., New Zealand - NZ, Great Britain - GB.

Box 29 - State

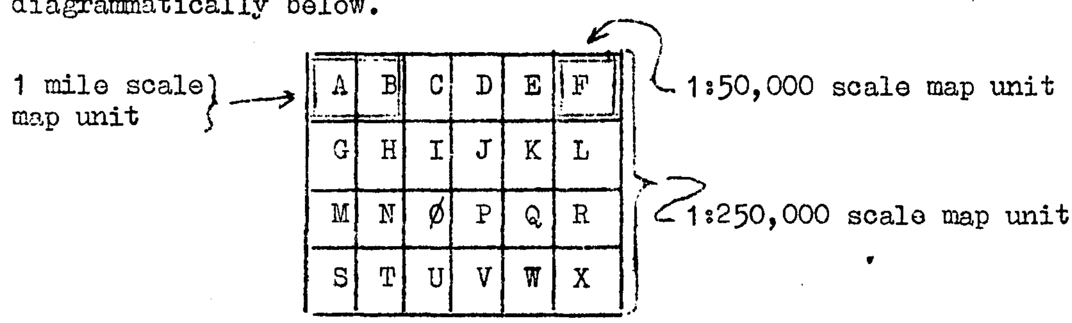
Code	Information	Code	Information
A	Antarctica	P	Papua and New Guinea
C	Australian Capital Territory	Q	Queensland
D	Northern Territory	T	Tasmania
I	Island Territories	V	Victoria
N	New South Wales	W	Western Australia

Wherever possible, the initial letter of the state or territory has been used. However, C (for A.C.T.) is taken from Capital, because A is used for Antarctica; D (for Darwin) is used for Northern Territory.

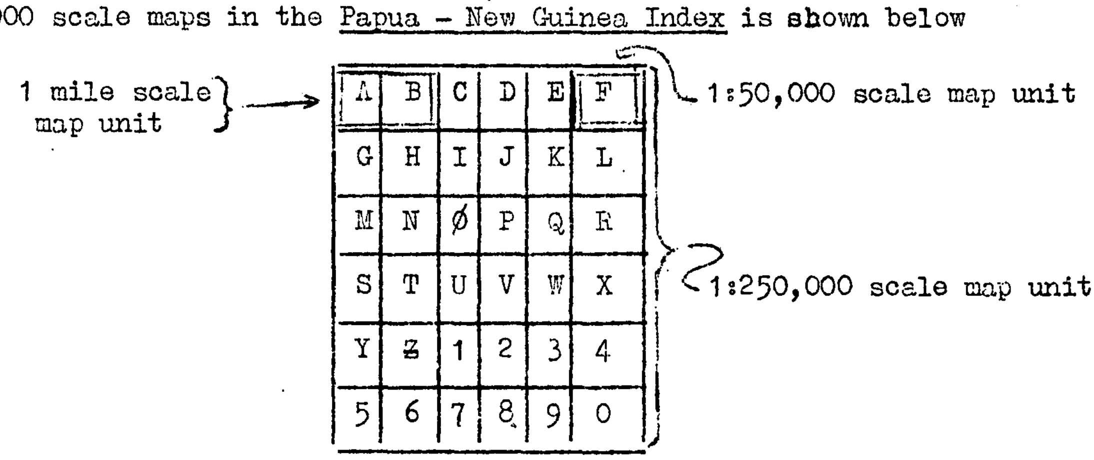
Boxes 30 to 34
1:250,000 Map Reference: A map number such as SD 55/13 (Cooktown) is coded by omitting the prefix 'S' and the oblique stroke, thus becoming D5513. SE 55/1 would become E 5501.

Box 35
1 Mile or 1:50,000 Map Reference

The procedure to be adopted for coding of 1 mile and 1:50,000 map areas within 4 mile or 1:250,000 scale maps in the Australian Index is shown diagrammatically below.



Coding of 1 mile and 1:50,000 map areas within 4 mile or 1:250,000 scale maps in the Papua - New Guinea Index is shown below



With the old and current map index System each 4 mile or 1:250,000 Sheet was divided into twelve 1-mile sheets In the next year or two the 1:250,000 scale map unit will be divided into 1:100,000 Sheets and also subdivided into twenty-four 1:50,000 scale map units. In Papua-New Guinea there are thirty-six 1:50,000 scale map units per 1:250,000 map unit.

The coding system illustrated above indicates the code letters that would be used for all 1:50,000 maps in a 1:250,000 map unit. Pairs of these units, e.g. A + B, etc., represents a 1-mile scale map at present in use. Thus when giving a sample location on a one-mile map, the 1:50,000 map code letter or digit used will depend on whether the sample is on the west or east half of the one-mile map. If on the western half A is used, if on the eastern half B and so on.

For the present, 1:100,000 scale maps are not included in the rock indexing scheme.

Air Photo Reference

The air photo boxes to the right of box 35 are purely for the convenience of the collector who can record an abbreviated photo reference when collecting the sample. This will be useful later when he plots the registered number on the photoscale overlays.

Boxes 36 to 46 - Stratigraphical name, rank, era, period, million years, epoch and stage.

As much of this stratigraphic information as possible should be given with each rock specimen and in the case of unconsolidated material (e.g. alluvium, stream sediments, soil etc). the parent rock should be indicated. In the case of alluvium or sediments where more than one rock type occurs upstream, the dominant rock type should be indicated.

Boxes 36 to 39: Stratigraphical Name: This is coded by the first letter and the three succeeding consonants of the geographical part of the name. The letters A, E, I, O, U, W, and Y are to be regarded as vowels. When a double consonant is present they are to be treated as a single consonant (see examples 5 & 6 below). Commonly, the geographical part of the name consists of two words - e.g., Cannibal Creek, Sain William, Mount Mulligan, and so on. The words Creek, Saint, Mount, Lake, River, etc. are to be omitted from the coding. Examples of coding follow:

	Information	Code
(1)	Hodgkinson Formation	- HDGK
(2)	Almaden Granodiorite	- ALMD
(3)	Laura Sandstone	- LR //
(4)	Nychum Volcanics	- NCHM
(5)	Saint William Beds	- WLM/
(6)	Cannibal Creek Granite	- CNBL

An oblique stroke / is used to fill up the blank spaces in short names, as in the code for the Laura Sandstone.

Box 40 - Rank One column (40) is used to signify the Rank of the rock unit. The Ranks are coded alphabetically, with sedimentary units in the A to H series, igneous in the J to R series, and metamorphics in the S to Z series. An oblique stroke indicates that there is no information.

Sediments		Igneous		Metamorphic	
Code	Information	Code	Information	Code	Information
A	Group	J	Complex	S	Complex
B	Formation	K	Porphyry	T	Metamorphics
C	Member	L	Granite	U	Schist
D	Beds	M	Volcanics	V	Gneiss
E	Sandstone	N	Dolerite	W	Amphibolite
F	Shale	P	Basalt	Z	Others
G	Limestone, Dolomite	R	Others	/	No information
H	Others				

Box 41 Era and General group

Code		Code	
1	Cainozoic	5	Lower Palaeozoic (Cambrian ordovician, Silurian)
2	Mesozoic	6	Proterozoic
3	Palaeozoic	7	Pre-Cambrian
4	Upper Palaeozoic (Devonian, Carboniferous Permian)	8	Archaean
		0	No information

Box 42 Period

Code	Information	Code	Information
A	Quaternary	K	Siluro-Devonian
B	Tertiary	L	Silurian
C	Cretaceous	M	Ordovician
D	Jurassic	N	Cambro-Ordovician
E	Triassic	Ø	Cambrian
F	Permo-Triassic	P	Sub-Cambrian
G	Permian	Q	Upper Proterozoic
H	Permo-Carboniferous	R	Middle Proterozoic
I	Carboniferous	S	Lower Proterozoic
J	Devonian	/	No information.

Box 43 Million Year Range

This is to be used for Age-determination samples only.

Code	Information	Code	Information
A	$<$15 thousand years	N	600 - 700 m.y.
B.	15 thousand to 1 m.y.	Ø	700-800 m.y.
C	1-7 m.y.	P	800-900 m.y.
D	7-70 m.y.	Q	900-1000 m.y.
E	70-135 m.y.	R	1000-1100 m.y.
F	135-180 m.y.	S	1100-1200 m.y.
G	180-225 m.y.	T	1200-1300 m.y.
H	225-270 m.y.	U	1300-1400 m.y.
I	270-350 m.y.	V	1400-1600 m.y.
J	350-400 m.y.	W	1600-1800 m.y.
K	400-440 m.y.	X	1800-2000 m.y.
L	440-500 m.y.	Y	2000-2500 m.y.
M	500-600 m.y.	Z	$>$ 2500
		/	No information

Box 44 Epoch

Code	Information
1	Recent
2	Pleistocene
3	Pliocene
4	Miocene
5	Oligocene
6	Eocene
7	Palaeocene
8	Lower
9	Middle
+	Upper
-	No information

Box 45 & 46: Stage A two-letter code using the first letter and next significant consonant of the name. As an example of coding, the names of stages in the Cretaceous system are listed below:

Name	Code
Neocomian	NC
Aptian	AP
Albian	AL
Cenomanian	CN
Turonian	TN
Senonian	SN
Maestrichtian	MS

In cases where, within one period, the first letter and the next consonant are the same - e.g., Llanvirnian and Llandeilian in the Ordovician - the next significant consonant after the first letter should be coded. Thus, the code for Llanvirnian is LV, and for Llandeilian, LD.

Stage is to be coded and sorted in conjunction with Period. In this way, confusion between stage names in different periods, but with the same code, will be avoided. Oblique strokes should be inserted where there is no information.

Box 47: Sample Significance

This relates the method of sampling a specimen to the rock body or deposit from which it was obtained.

Typical of rockmass or deposit	Typical of a particular part of a rock-mass or deposit	Relationship to rockmass or deposit not known.	
B	K	S	Single specimen selected for a particular purpose*.
C	L	T	Other single specimen.
D	M	U	Composite specimen, fractions combined quantitatively proportional to some rock characteristic.
E	N	V	Composite, fractions combined intuitively.
F	Ø	W	Composite, fractions combined in taking (channel sample).
G	P	X	composite in nature (drill cuttings).
		/	No information.

Examples of coding:

(a) A specimen which is typical of a rockmass (B to G) and which is purposofully selected (B,K,S) is coded B.

(b) A composite specimen, fractions combined quantitatively proportional to some rock characteristic (D,M,U), and typical of a particular part of a rock mass (e.g. a facies in a sedimentary bed, or a chilled margin of an igneous intrustion), i.e. K to P, is coded M.

* It is not necessary to specify the particular purpose for coding.

Source and A.V.M.

Source implies how and where a specimen was collected - e.g. if it comes from an outcrop or diamond drill hole, or a tailings dump. Source is coded in conjunction with A.V.M. which, broadly speaking, gives an idea of the kind of material that was collected - e.g. rock, soil, water, etc. (metaphorically - Animal, Vegetable or Mineral). The code to be used is the capital letter shown in brackets on the left of each example. (It is not necessary to use the brackets in filling in the form). Source and A.V.M. will only be used to describe Parent material and not Fractions.

SOURCE
Box 48:

Code	Information
A.	Natural exposure (outcrop, surface soil, etc.).
B.	Artificial exposure (quarry, road cutting, pit, etc., but excluding mine workings and foundations (engineering).
C.	Floater (loose block or boulder on surface, composed of material similar to the underlying rock).
D.	Erratic (a transported floater, different from the underlying rock).
E.	Volcanic exhalation product (refers to gas, water, or sublimate obtained from a volcano - see A.V.M., it does not refer to lavas or pyroclastic rocks - these are coded as natural exposure
F.	Surface seepage (of water, oil).
G.	Stream sample (of water, sediment, etc.)
H.	Lake sample (of water, sediment, etc.)
I.	Marine sample (of water, sediment, etc.)
J.	Beach sample (of sediment, detrital concentrate, etc.).
K.	Auger sample.
L.	Bore, well, diamond drill hole.
M.	Smelter, refinery.
N.	Mill.
Ø.	Mine
P.	Mine dump
Q.	Foundations (engineering).
R.	Cave deposit.
S.	Extra-terrestrial
Z.	Miscellaneous.

Box 49: A.V.M.

Code	Information
A.	Rock
B.	Oriented specimen.
C.	Core.
D.	Cuttings, sludge.
E.	Soil
F.	Sediment sample (unconsolidated material, e.g., sand, clay; excluding soil)
G.	Detrital concentrate (natural).
H.	Ore, metallic and non-metallic.
I.	Mineralised rock lode and potential ore.
J.	Refinery, smelter or mill - product of economic value e.g. matte, bullion, mill concentrate etc.
K.	Refinery, smelter or mill - rejected products e.g. tailings, sludge, slag, battery sands etc.
L.	Construction material e.g. building stone, aggregate, etc.
M.	Water.
N.	Oil, tar.
Ø.	Gas.
P.	Sublimate.
Q.	Encrustation.
R.	Organic substance - vegetable*
S.	Organic substance - animal*

Box 50 to 55: Report Reference

Record; Report or Bulletin number will be coded by the Transit Room Manager. This is not to be filled in by field personnel.

Boxes 56 to 67: Parent and Fraction

Two lines of boxes each with identical numbers have been printed on the geochemical bags so that the parent geological material can be described as well as the derived fraction e.g. where a biotite mica fraction has been separated from a granite, the granite will be described as the Parent in boxes 56 to 67 and the biotite mica as the Fraction in the lower row of boxes 56 to 57. The advantage of having these two lines of boxes on the same packet is that all remaining data on the form is common to both samples with the exception of Source and A.V.M., and two master cards can be punched from the data on this form. Where a fraction has been collected without sampling the parent, a description of the parent should still be given in the Parent Information boxes. In all cases the question in the top right corner, whether parent material has been collected, should be answered by crossing out yes or no.

Box 56: SAMPLE TYPE

Code	Information	Code	Information
1	Igneous	6	Minerals
2	Metamorphic	7	Water
3	Sedimentary	8	Vegetation
4	Soils	0	No information
5	Detritus		

This information qualifies that contained in columns 57 to 67; i.e., if "soils" 4 is coded here, then the information coded in columns 57 to 67 is about soils; if "minerals" 6 is coded, then the information in the next eleven columns is about mineralogy.

Boxes 57 to 67: SAMPLE INFORMATION

The information coded here is related to the subject coded in the previous column (56 see above).

Igneous Rocks (Box 56 Code 1)

Box 57: GENERAL DESCRIPTION

The general description is to be used in order to give a general name to rocks in hand specimen, and to facilitate sorting of general rock types with specimens that have detailed names. They are also used in order to define pyroclastic rock names, e.g., basaltic lapilli tuff, rhyolite vitric tuff, andesitic agglomerate, etc.

Code	Information	Code	Information
A	Granitic	M	Gabbroic
B	Micro-granitic	N	Doleritic
C	Granodioritic	Ø	Basaltic
D	Micro-granodioritic	P	Basaltic glass
E	Rhyolitic	Q	Undersaturated rocks
F	Rhyolitic glass	R	Ultramatic
G	Syenitic	S	Acid pegmatite
H	Micro-syenitic	T	Intermediate pegmatite
I	Trachytic	U	Basic pegmatite
J	Dioritic	X	Xenolithic
K	Micro-dioritic	/	No information
L	Andesitic		

IGNEOUS ROCKS (Box 56 code 1)

Boxes 58 to 60: Rock Name. These are given in Table 1. The names are based on an adaptation of the classification of S.R. Nockolds (1954). In rock nomenclature, all officers should use the same classification. The Nockolds classification has been chosen because it is simple; the names are based on mineralogical characteristics. However, Nockolds, in his paper, presents averages of chemical analyses for each of his rock types, thus relating, in a general way, mineral content to chemical composition. The classification is fully described by Morgan (1964).

Code	Name
	Acid Rocks
101	Calc-alkaline granite
102	Calc-alkaline micro-granite
103	Calc-alkaline rhyolite
104	Alkaline granite
105	Alkaline micro-granite
106	Alkaline rhyolite
107	Peralkaline granite
108	Peralkaline micro-granite
109	Peralkaline rhyolite
110	Adamellite
111	Micro-adamellite
112	Dellenite
113	Granodiorite
114	Micro-granodiorite
115	Rhyodacite
116	Tonalite
117	Micro-tonalite
118	Dacite
119	Pitchstone
120	Obsidian
121	Felsite
122	Pumice
	Intermediate rocks
201	Calc-alkaline syenite micro-syenite
202	Calc-alkaline
203	Calc-alkaline trachyte
204	Alkaline syenite
205	Alkaline micro-syenite
206	Alkaline trachyte
207	Peralkaline syenite
208	Peralkaline micro-syenite
209	Peralkaline trachyte
210	Monzonite
211	Micro-monzonite
212	Latite
213	Mangerite
214	Micro-mangerite
215	Doreite
116	Mugearite
217	Diorite
218	Micro-diorite
219	Andesite
220	Andesitic basalt
	Basic Rocks
301	Gabbro
302	Norite
303	Troctolite
304	Dolerite
305	Micro-norite
306	Micro-troctolite
307	Basalt
308	Hypersthene-basalt
309	Picrite basalt
310	Leuco-gabbro
311	Leuco-norite
312	Leuco-troctolite
313	Leuco-dolerite
314	Leuco-micro-norite
315	Leuco-micro-troctolite
316	Leuco-basalt
317	Ferro-gabbro
318	Ferro-dolerite
319	Andesine-dolerite
320	Oligoclase-dolerite
321	Kentallenite
322	Micro-kentallenite
323	Trachybasalt
324	Shonkinite
325	Micro-shonkinite
326	Mela-trachyte
	Feldspathoidal Basic and Intermediate rocks.
401	Theralite
402	Micro-theralite
403	Tephrite
404	Basanite
405	Teschenite
406	Malignite
407	Foyaite
408	Micro-foyaite
409	Phonolite
	Lamprophyres
451	Lamprophyre
452	Minette
453	Vogesite
454	Soda vogesite
455	Kersantite
456	Spessartite
457	Camptonite
458	Alnoite
459	Monchiquite
	Ultra-alkaline rocks
501	Ijolite
502	Nephelinite
503	Urtite
504	Moltoigite
505	Fasinite
506	Jacupirangite
507	Leucitite
508	Fergusite
509	Analcitite
510	Melilitite
511	Uncompahgrite
512	Carbonatite
512	Carbonatite
	Ultramafic Rocks
601	Dunite
602	Olivinite
603	Peridotite
604	Orthopyroxenite
605	Clinopyroxenite
606	Pyroxenite
607	Perknite
608	Magnetitite
609	Chromitite
610	Ilmenitite
611	Limburgite
	Spilitic Rocks
701	Spilite
702	Keratophyre
703	Quartz keratophyre
	Late-stage rocks
801	Granite-pegmatite
802	Granite-aplite
803	Tholeiitic dolerite-granophyre
804	Tholeiitic dolerite-pegmatite
805	Alkali dolerite-pegmatite
806	Schorl-rock
	Pyroclastic Rocks
901	Agglomerate
902	Volcanic conglomerate
903	Volcanic breccia
904	Lapilli tuff
905	Tuff
906	Vitric tuff
907	Vitric crystal tuff
908	Vitric, crystal and lithic tuff
909	Crystal tuff
910	Crystal and lithic

221	Basaltic andesite
222	Hawaiite
223	Hyalo-andesite
224	Ferro-diorite

911	Lithic tuff
912	Lithic and vitric tuff
913	Palagonite tuff
914	Sorted tuff
915	Welded tuff
916	China-stone tuff
917	Intrusion breccia
918	Explosion breccia
909	Tuffisite
000	No information.

Metamorphic Rocks (Box 56 Code 2)
Box 57: General Description This is to be used for hand specimen names, and to be filled in for rocks with detailed names, in order to facilitate sorting of general rock types.

Code	Information	Code	Information
A	Amphibolite	J	Migmatite
B	Buchite	K	Mylonite
C	Charnockite	L	Phyllite
D	Eclogite	M	Phyllonite
E	Gneiss	N	Schist
F	Granofels	P	Skarn
G	Hornfels	Q	Slate
H	Marble	R	Spotted Slate
I	Metaquartzite	S	Metasomatic
		/	No information

Metamorphic Rocks (Box 56 Code 2)
Boxes 58 to 60: Rock Name Rock names can be sorted into the very general types (contact, dynamic, regional, etc.) on the first figure (Column 58) of the code. The code is shown in Table II. Metamorphic rock nomenclature is described by Morgan (1964).

Table II - Metamorphic Rock Names

Contact Metamorphic Rocks		Dynamic Metamorphic Rocks		Regional Metamorphic Rocks		Miscellaneous Marble	
Code	Information	Code	Information	Code	Information	Code	Information
001	Hornfels	201	Ultramylonite	301	Slate	901	Marble
002	Skarn	202	Hartschiefer	302	Phyllite	902	Predazzite
003	Tactite	203	Mylonite	303	Semi-schist	903	Ophicalcite
004	Buchite	204	Cataclasite	304	Schist	904	Metaquartzite
005	Spotted slate	205	Mylonite gneiss	305	Gneiss		
		206	Blastomylonite	306	Granofels	905	Charnockite
Metasomatic Rocks		207	Hyalomylonite	307	Amphibolite		
101	Greisen	208	Gangmylonite	308	Eclogite	///	No information
102	Schorl rock	209	Pseudotachylite	309	Migmatite		
		210	Protomylonite				
		211	Fault breccia				
		212	Phyllonite				

Sedimentary Rocks (Box 56 Code 3)

Box 57: General Description - The general description is to be used in order to give a general name to rocks in hand specimens and to facilitate sorting of general rock types with specimens that have detailed names.

Code	Information	Code	Information	Code	Information
A	Conglomerate	H	Limestone	P	Chert
B	Breccia	I	Dolomite	Q	Flint
C	Sandstone	J	Peat	R	Other siliceous
D	Greywacke	K	Coal	S	Phosphorite
E	Siltstone	L	Bitumen	/	No information
F	Mudstone	M	Evaporite		
G	Shale	N	Bedded iron ore		

Sedimentary Rocks (Box 56 Code 3)

Boxes 58-60: Rock Name These are given in Table III, see below). The names are used as defined in Pettijohn (1957), and Guppy (1964).

Table III Sedimentary Rock Names

Code	Name
	Rudites
001	Oligomict conglomerate
002	Polymict conglomerate
003	Tilloid
004	Tillite
005	Intraformational conglomerate
006	Intraformational breccia
007	Breccia
	Pebbles
051	Acid igneous, coarse
052	Acid igneous, fine
053	Basic igneous, coarse
054	Basic igneous, fine
055	Contact metamorphic
056	Regional metamorphic
057	Dynamic metamorphic
058	Metasomatic rock
059	Rudite pebble
060	Sandstone pebble
061	Siltstone pebble
062	Carbonate pebble

Code	Name
	Lutites
201	Claystone
202	Mudstone
203	Shale
204	Siltstone
205	Loess
206	Laterite
207	Bauxite
	Limestone and Dolomites (Autochthonous)
301	Bioherm
302	Klintite
303	Biostrome
304	Pelagic limestone
	Limestones and Dolomites (Detrital)
321	Calcirudite
322	Dolorudite
323	Calcarenite
324	Dolarenite
325	Calcilutite
326	Dololutite
327	Coquina
328	Micrococquina
329	Encrinite
330	Spergenite
331	Lithographic limestone
332	Tufa
333	Travertine
334	Caliche
335	Marlstone
336	Sandy limestone (Fontainbleau)

Code	Name
	Siliceous
401	Chert
402	Flint
403	Jaspilite
404	Jasper
405	Porcellanite
406	Diatomite
407	Radiolarite
408	Siliceous Sinter
	Organic
501	Peat
502	Lignite, brown coal
503	Sub-bituminous coal
504	Bituminous coal
505	Semi-bituminous coal
506	Anthracite
507	Cannel coal
508	Boghead coal
509	Oil shale
510	Torbanite
551	Asphalt
552	Albertite
553	Elaterite
554	Ozokerite

Code	Name
	Iron-Bearing
601	Bedded iron sulphide
602	Bedded siderite
603	Clay ironstone
604	Sedimentary hematite
605	Bog iron ore
606	Bedded iron silicate
607	Ferricrete
608	Silcrete
	Evaporites
701	Halite
702	Gypsum
703	Anhydrite
	Miscellaneous
901	Greensand
951	Phosphorite
952	Guano
///	No information

	Arenites
101	Orthoquartzite
102	Protoquartzite
103	Subarkose
104	Arkose
105	Subgreywacke
106	Lithic grey-wacke
107	Feldspathic greywacke

Soils (Box 56 Code 4)
Box 57: General Description

Code	Information	Code	Information
1	Alluvial soils	3	Calcareous coastal sands
2	Skeletal soild	4	Wind-blown dust and and
		5	Pedalfers
		6	Pedocals
		0	No information

Soils (Box 56 Code 4)
Box 58: Soil Type-Pedalfers (column 58)

Code	Information
1	Soil dominated by acid peat or peaty alluvial horizon, e.g. moor peats, alpine humus soils, moor podsol peats, and acid swamp soils.
2	Soil acid with organic, sesquioxide, and in some cases clay alluvial horizons, e.g. podsols and ground water podsol.
3	Soil acid and with clay and sesquioxide horizons, e.g., laterites, greybrown, brown, red, yellow, and non-calcic podsols.
4	Soil acid to neutral and lacking pronounced eluviation of clay, e.g., yellow earths, Krasnozem, lateritic Krasnozem, lateritic red earths, terra-rossa, and prairie soils.
0	No information.

Soils (Box 56 Code 4)
Box 59: Soil Type - Pedocals

Code	Information
1	Soil dark coloured and slightly acid to neutral in eluvial horizons, calcareous illuvial horizons, e.g., black earths, wiesenboden, brown forest soils, redzinas, ground water, and fen soils.
2	Soil saline showing post-saline structure in the illuvial horizon, e.g., solonchaks, solonetz, solodised solonetz, soloths, and solonised brown soils.
3	Soil with slightly acid to neutral eluvial horizons and calcareous illuvial horizons, e.g., red brown earths, brown earths, brown soils of light texture, arid red earths, and grey calcareous soils.
4	Soil with neutral to alkaline, weakly developed eluvial horizons and calcareous and/or gypseous illuvial horizons, e.g., grey to brown soils of heavy texture.

5 Soil with deflated, slightly acid to alkaline eluvial horizons and calcareous and/or gypseous illuvial horizons, e.g., desert loams, grey-brown and red calcareous desert soils, red and brown hard pan soils, desert plain soils, calcareous laterite soils, and desert tableland soils.

0 No information.

Soils (Box 56 Code 4)
Box 60: Parent - Igneous Rocks

Instrusive	Extrusive (flow)	Pyroclastic	Not known	
+	-	0(zero)	/	No information
B	K	S	2	Granitic, rhyolitic
C	L	T	3	Granodioritic, dacitic
D	M	U	4	Syenitic, trachytic
E	N	V	5	Dioritic, Andesitic
F	Ø	W	6	Gabbroic, basaltic
G	P	X	7	Undersaturated rocks
H	Q	Y	8	Ultramafic
I	R	Ƶ	9	Pegmatite, aplitic

Soils (Box 56 Code4)
Box 61: Parent - Metamorphic Rocks

9

Regional	Contact	Dynamic	Not Known	
+	-	0 (zero)	/	No information
			1	Not known
B	K	S	2	Pelitic
C	L	T	3	Psammitic
D	M	U	4	Calc-silicate
E	N	V	5	Marble
F	Ø	W	6	Orthogneiss
G	P	X	7	Paragneiss
H	Q	Y	8	Aluminous metamorphic
I	R	Ƶ	9	Ferruginous metamorphic

Soils (Box 56 Code 4)
Box 62 Parent-Sedimentary Rocks (Column 62)

Code	Information	Code	Information
A	Conglomerate	J	Peat
B	Breccia	K	Coal
C	Sandstone	L	Bitumen
D	Greywacke	M	Evaporite
E	Siltstone	N	Bedded iron ore
F	Mudstone	Ø	Chert
G	Shale	P	Flint
H	Limestone	Q	Other siliceous
I	Dolomite	R	Phosphorite
		/	No information

Soils (Box 56 Code 4)

Box 63: Soil Horizon

Code	Information
1	A_{00} horizon
2	A_0 horizon
3	A_1 horizon
4	A_2 horizon
5	B_1 horizon
6	B_2 horizon
7	C horizon
0	No information

Soils (Box 56 Code 4)

Box 64: Topography

Code	Information
1	Flat
2	Rolling
3	Steep
4	Very steep
5	Broken and irregular
0	No information

Soils (Box 56 Code 4)

Box 65: Rainfall

Code	Information
1	0 - 5 inches per year
2	5 - 10 inches per year
3	10- 20 inches per year
4	20 - 30 inches per year
5	30 - 40 inches per year
6	40 - 50 inches per year
7	50 - 60 inches per year
8	60 - 80 inches per year
9	80 -100 inches per year
+	Over 100 inches per year
0	No information

Soils (Box 56 Code 4)

Box 66: Soil Components

Code	Information	Code	Information
A	Quartz	K	Muscovite
B	Orthoclase	L	Biotite
C	Albite	M	Chlorite
D	Oligoclase	N	Hematite
E	Labradorite	O	Limonite
F	Anorthite	P	Clay
G	Apatite	Q	Ferruginous gravel
H	Magnetite	R	Aluminous gravel
I	Amphiboles and pyroxenes	S	Siliceous gravel
J	Olivine	T	Organic matter
		/	No information

Note, code only the dominant component

Detritus (Box 56 Code 5)

Box 57: General description

Code	Information
1	Colluvium
2	Alluvium
3	Swamp sediment
4	Stream sediment
5	Estuarine sediment
6	Off-shore sediment
7	Gravity concentrate
8	Magnetic fraction
9	Seepage area
0	No information

MINERALS (Box 56 Code 6)

Box 57: General Description

Mineralized Sample	Gangue	Wall Rock	Others	
+	-	0 (zero)	/	No information
B	K	S	2	Carbonate
C	L	T	3	Native element
D	M	U	4	Sulphide or sulphosalt
E	N	V	5	Oxide, hydroxide
F	Ø	W	6	Sulphate
G	P	X	7	Uranium compound
H	Q	Y	8	Silicate
I	R	Ƶ	9	Others

Dana Class Number (Columns 58 and 59)

The class number and mineral groups are shown in Table IV Code the tens in columns 58 and the units in column 59.

Mineral Name (Columns 60 to 64)

A five letter code using the first letter and the next four consonants - e.g., chalcopyrite would be coded CHLCP; biotite would be coded BTT in columns 60 to 62; oblique strokes are used to fill up the spaces in columns 63 and 64, thus biotite, fully coded, is BTT//.

Minerals

Table IV Dana Class Number

Code	Information
01	Native elements
02	Sulphides
03	Sulphosalts
04	Simple oxides
05	Oxides containing U, Th and Zr.
06	Hydroxides and Oxides containing hydroxyl.
07	Multiple Oxides
08	Multiple Oxides containing Nb Ta, and Ti.
09	Normal Anhydrous and Hydrated Halides.
10	Oxyhalides and Hydroxyhalides
11	Halide complexes, Alumino-fluorides.
12	Compound Halides
13	Acid Carbonates
14	Anhydrous Normal Carbonates
15	Hydrated Normal Carbonates
16	Carbonates containing Hydroxyl and Halogen
17	Compound Carbonates
18	Normal Anhydrous and Hydrated Nitrates.
19	Nitrates containing Hydroxyl or Halogen
20	Compound Nitrates
21	Normal Anhydrous Hydrated Iodates.
22	Iodates containing Hydroxyl or Halogen.
23	Compound Iodates
24	Anhydrous Borates
25	Hydrated Borates
26	Borates containing Hydroxyl or Halogen
27	Compound Borates
28	Anhydrous acid and Normal Sulphates
29	Hydrated Acid and Normal Sulphates
30	Anhydrous sulphate containing hydroxyl or halogen
31	Hydrated sulphates containing hydroxyl or halogen
32	Compound sulphates
33	Selenates and Tellurates
34	Selenites and Tellurites
35	Anhydrous Normal Chromates
36	Compound Chromates
37	Anhydrous Acid Phosphates etc.
38	Anhydrous Normal Phosphates etc.
39	Hydrated acid Phosphates etc.
40	Hydrated Normal Phosphates etc.
41	Anhydrous Phosphates etc. containing hydroxyl or halogen.
42	Hydrated Phosphate etc. containing hydroxyl.
43	Compound Phosphates etc.
44	Antimonites
45	Acid and Normal Antimonites and Arsenites
46	Basic or Halogen - containing Antimonites and Arsenites
47	Vanadium oxysalts.
48	Normal Anhydrous Molybdates and Tungstates.
49	Basic and Hydrated Molybdates and Tungstates.
50	Salts of organic acids.
	ANHYDROUS SILICATES (Disilicates, Polysilicates Division)
51	Feldspar group
52	Leucite group
53	Pyroxene group
54	Amphibole group
	(Orthosilicates Division)
55	Nephelite group
56	Sodalite group
57	Helvite group
58	Garnet group
59	Chrysolite group
60	Phenacite group
61	Scapolite group
62	Zircon group
63	Danburite group
64	Datolite group
65	Epidote group
	(Subsilicates Division)
66	Humite group
	HYDROUS SILICATES (Zeolite Division)
67	Mordenite group
68	Healandite group
69	Phillipsite group
70	Chabazite group
71	Natrolite group
	(Mica Division)
72	Mica group
73	Clintonite group
74	Chlorite group
	(Serpentine and Talc Division)
75	Serpentine
76	Talc
	(Kaolin Division)
77	Kaolin minerals group
78	Hydrous aluminium silicates
	(Concluding Division)
79	Hydrous iron silicates
80	Hydrous manganese silicates
81	Hydrous copper silicates
82	Silicates containing other acid radicals
83	Titano silicates

Minerals
Box 65: Genetic classification (Column 65)

Code	Information	Code	Information
+	Hypogene	6	Detrital concentrates
1	Supergene	7	Evaporite
2	Metamorphic	8	Residual concentrate
3	Magmatic segregation	9	Other
4	Syngenetic (includes bedded deposits).	0	Other information
5	Oxidized ore (includes gossans).		

Box 66: Form of deposit

Code	Information
+	Tabular - lenticular discordant
1	Tabular - lenticular concordant (Includes bedded and alluvial deposits).
2	Massive
3	Irregular
4	Local segregation (ore segregated into isolated veins, pods, pockets).
5	Stockwork (complex of veins and ore filling complex of fissures or shears).
6	Blanket (relatively large areal extent - e.g., laterite, evaporite). Includes dune deposits.
7	Banded (sedimentary or metamorphic banding).
8	Disseminated
9	Other
0	No information

Box 67: Major Product (Column 67)

Code	Information	Code	Information
A	Pb - Zn	N	As - Sb
B	Cu - Mo	Ø	Hg
C	U - V	P	Bi
D	Fe - Mn	Q	Be
E	Al - Mg	R	Se - Te
F	W	S	Rare earths
G	Cu	T	Platinum group
H	Co - Ni	U	Phosphate
I	Th	V	Nb - Ta
J	Sn	W	Barium minerals
K	Cr	X	Strontium minerals
L	Au	Y	Zirconium - Hafnium
M	Ag	Z	Others
		/	No information

Boxes 68 to 75: Sample Depth and Interval

Boxes 68 to 72 Depth (surface to top of sample interval)

This gives the depth from the surface to the top of the sample in feet (recorded in columns 68 to 71), and inches (in column 72. For inches, code the digits 1 to 9 for 1 to 9 inches, 10 inches is coded by a minus sign and 11 inches by a plus sign. Figure 0 (zero) must be used if there are no inches to record, in order to prevent ambiguities in selection on the sorter-selector equipment.

Feet are coded in columns 68 to 71, and by coding numerically, a depth of 9999 feet can be recorded where footage occupies less than 4 columns, zeros are inserted in unused columns. For depths greater than this, alpha-coding in column 68 is used, the zone punches + and - and 0 (zero) adding 10,000, 20,000 and 30,000 feet respectively, to the footage shown by the digits, according to the scheme shown below:

Code	Depth	Code	Depth	Code	Depth
+	10,000 feet	-	20,000 feet	0 (zero)	30,000 feet
A	11,000 feet	J	21,000 feet	/ (oblique stroke)	31,000 feet
B	12,000 feet	K	22,000 feet	S	32,000 feet
C	13,000 feet	L	23,000 feet	T	33,000 feet
D	14,000 feet	M	24,000 feet	U	34,000 feet
E	15,000 feet	N	25,000 feet	V	35,000 feet
F	16,000 feet	O	26,000 feet	W	36,000 feet
G	17,000 feet	P	27,000 feet	X	37,000 feet
H	18,000 feet	Q	28,000 feet	Y	38,000 feet
I	19,000 feet	R	29,000 feet	Z	39,000 feet

Boxes 73 to 75: Sample Interval. This indicates the vertical extent of the sample interval in the drill hole shaft etc. at the depth recorded in the previous field. Footage is recorded in columns 73 and 74 and inches are coded in column 75 in the same way as in column 72, described above. In vacant columns, zeros are inserted.

Boxes 76 and 77: Fraction Size. For the natural sample not split into size fractions, insert 00 (double zero) in these columns. Column 76 gives the coarse size limit, and 77 the finer limit. If either limit is unknown, insert an 0 (zero) is made in the relevant column.

The particle size limit is measured in millimetres; the position of the zone punches + (plus) - (minus) and 0 (zero), if present determine the position of the decimal point, according to the scheme shown below:

No zone punch		+ zone punch		- zone punch		0 (zero) zone punch	
Code	Particle size mm.	Code	Particle size mm.	Code	Particle size mm.	Code	Particle size mm.
9	9	I	0.9	R	0.09	Z	0.009
8	8	H	0.8	Q	0.08	Y	0.008
7	7	G	0.7	P	0.07	X	0.007
6	6	F	0.6	O	0.06	W	0.006
5	5	E	0.5	N	0.05	V	0.005
4	4	D	0.4	M	0.04	U	0.004
3	3	O	0.3	L	0.03	T	0.003
2	2	B	0.2	K	0.02	S	0.002
1	1	A	0.1	J	0.01	/	not sieved

Table V and VI show U.S. Standard Series and B.S.S. Standard Sieve sizes respectively, together with the sizes of the openings. These are given to compare with the code above.

Table V U.S. Standard

Mesh	Opening mm.	Mesh	Opening mm.	Mesh	Opening mm.	Mesh	Opening mm.
2.5	8.0	12	1.7	45	0.35	200	0.074
3	6.7	14	1.4	50	0.30	230	0.062
3.5	5.7	16	1.2	60	0.25	270	0.053
4	4.8	18	1.0	70	0.21	325	0.044
5	4.0	20	0.84	80	0.18		
6	3.4	25	0.71	100	0.15		
7	2.8	30	0.59	120	0.125		
8	2.4	35	0.50	140	0.105		
10	2.0	40	0.42	170	0.088		

Table VI B.S.S. Standard

Mesh	Opening mm.	Mesh	Opening mm.	Mesh	Opening mm.	Mesh	Opening mm.
5	3.4	14	1.2	36	0.42	100	0.15
6	2.8	16	1.0	44	0.35	120	0.12
7	2.4	18	0.85	52	0.30	150	0.10
8	2.1	22	0.70	60	0.25	170	0.089
10	1.7	25	0.60	72	0.21	200	0.076
12	1.4	30	0.50	85	0.18	240	0.060

Boxes 78 and 79: pH Value

The two columns cover the range pH0 to pH11.9. This range is considered adequate for any foreseeable requirements. Decimal points are not coded (they are assumed to be between columns 78 and 79). A pH below 1 is shown as 02 etc., between 1 and 9.9 as 12 (1.2), 43 (4.3) etc. A pH of more than 9.9 is shown by punching + (plus) for 10 and - (minus) for 11. Thus 10.2 is coded -2 and 11.4 is coded +4. Double zero indicates no information.

Box 80: Contamination

This records any features that are likely to result in the contamination of the sample at the sampling site.

Code	Information
1	Mine workings
2	Smelter fumes or waste.
3	Mining waste used for road works; rail ballast etc.
4	Industrial and town effluents, and drainage.
5	Agricultural and horticultural activity.
6	Prospecting activity.
0	No information.

APPENDIX VI

INSTRUCTIONS FOR COMPLETION OF SAMPLE SUBMISSION FORM

This form has been designed principally for the submission of single hand specimens. The form will also be used for submitting batches of geochemical samples. For these however only limited information need be recorded on the form. The following sections should be completed.

Originator and Field Party: The originator should be the party leader or where there is no party this would be the collector himself.

Date: Refers to date of dispatch of sample to the Transit Room.

Registered Nos: indicates the range of sample numbers submitted.

Batch No: This is for identification of boxes of samples by personnel of the Transit Room and Laboratory. The year and Prefix Number should be used for this purpose e.g. 6512, Batch 2 and should be clearly written on the outside of sample boxes with Textacolour.

Explanation

The Explanation must be a clear and concise statement of what the submitter requires to be done with the samples and for what reason.

The analytical programme for each geochemical project should be determined after analysis of orientation material (see p. 4) and after joint consultation with Supervisor and officer-in-charge of laboratory.

In submission of routine samples for regional surveys, analytical requirements for each type of sample (e.g. stream sediment, rock, soil, gossan, mineralised rock) should be indicated under the heading 'Explanation' and the B.M.R. File or Record number should be noted for reference to the initial orientation survey.

Where orientation or special project samples are being submitted, the originator should indicate the nature of the samples, the purpose of the investigation, the elements to be determined and whether any elements require special attention (ie. high sensitivity, high accuracy, differential extraction etc.).

Arbitrary grids

Where samples are being collected on grids not aligned with military or metric grid ordinates the position of two points on the base line should be given in terms of the arbitrary and military co-ordinates. In this case the M.G. Zone box should be filled in together with the boxes bracketed under 'For Mil. grid calculation. Two points on base line' (see p.11).