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COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS:

1964/57

REGIONAL GEOCHEMICAL SAMPLING METHODS

by

A.L. Mather

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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. As a measure of the activity in this field the estimated number of samples collected each year in Russia is 7,000,000, in Africa 1,500,000, and in N. America 500,000.* The Bureau has carried out some preliminary orientation work in this field, and now plans to introduce 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. Systematic sampling and analysis of 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 or metallogenetic provinces.

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 the limits of a basin in which one

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* Hawkes & Webb (1962) Geochemistry in Mineral Exploration

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 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 and bank soils 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 banks 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 berylliferous pegmatites 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 (in ball pen) and should be completed according to the abbreviated code in Appendix IV.A more detailed code will eventually be issued to all geologists and sample collectors.

<u>Bank alluvium</u>

In many places there is a lack of fine material in stream sediments and in these circumstances it is convenient to collect bank alluvium. However the relationship between sediment and bank alluvium has not yet been firmly established and before alluvium can be accepted as an alternative material, comparative studies must be made in a variety of widely differing environments. Zimmerman investigated this aspect in regional geochemical studies in N. Queensland. He found that although there was a direct relationship between the trace element content of the stream sediment and bank alluvium, the alluvium in the majority of samples, had a higher trace metal content. Comparative studies are needed in other areas and it would be appreciated if geologists or field assistants could collect a limited number of alluvium samples in conjunction with the active sediment samples (say 100 samples in each of 2 or 3 localities).

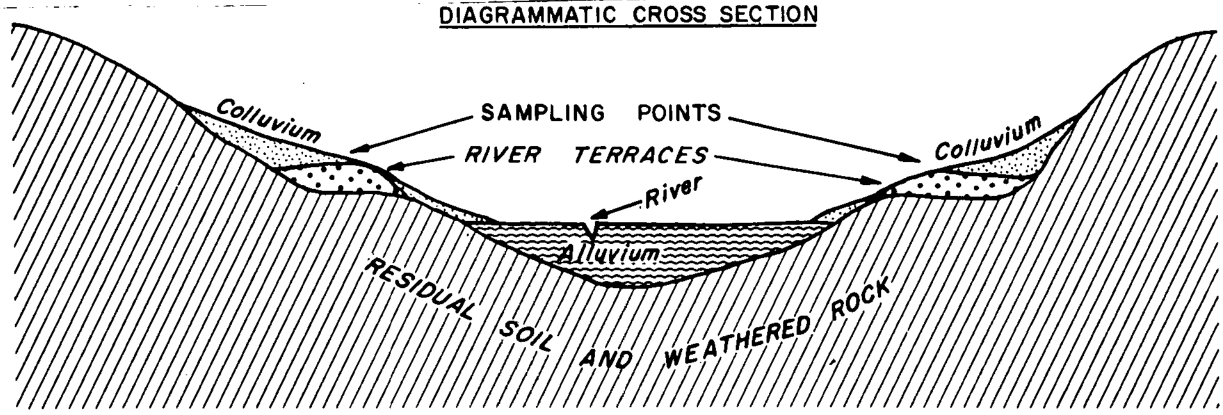
The alluvium (N.B. not eluvium) should be sampled from both banks near to the sediment sample point. The bank faces should be scraped clean and a channel sample taken from below the organic horizon down to the stream or dry stream bed and the two bank samples composited. Sufficient of the sample should be sieved through an 80-mesh sieve to quarter fill a sample bag. If the sample is damp, siève through a coarse, say 28 mesh sieve, place sample in large plastic bag, dry sample at base and then sieve through an 80 mesh sieve.

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.

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.

DIAGRAMMATIC CROSS SECTION



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

Ideally the samples should be spaced at ¼ mile intervals but this would depend on accessibility and on the topography.

Rock Samples

Rock samples should be collected at or near the same site as rock specimens collected for petrological examination. A fragment broken off the petrological sample is suitable. 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 also be noted.

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 brought back to base camp for panning. Details should be recorded according to the geochemical code book.

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 northing and easting 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.

SAMPLES OF TYPE MINERALIZATION

It would be extremely difficult to design a comprehensive scheme of analysis that would be applicable to the wide variety of rocks and the great diversity of geological associations that occur in Australia. The selection of trace elements for analysis will depend primarily on the rock types in the area concerned, and on the type of existing or potential mineralization. There is a sparsity of data concerning the suites of trace elements associated with economic and sub-economic mineral deposits in Australia. It is hoped that this shortage will be rectified during the course of this survey, and members of the Bureau staff are requested to submit specimens from type mineralization in their field areas. The samples, where possible should be accompanied by specimens of the host or wall rock.

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.

A map showing a typical pattern of drainage samples collected in regional geochemical reconnaissance is shown in Appendix IV. However the density of sampling here is far greater than would be expected in 1:250,000 scale mapping.

All samples should be addressed to the Chief Geologist enclosing a standard sample submission form.

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 six digits stamped in the box titled 'Field Number' are positioned exactly under box numbers 17 to 22. Boxes 17 and 18 will be above the project or sampler's prefix number. 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 plastic, aluminium or cardboard box will prevent contamination and pulping of the packets. Rothmans cigarette cartons are suitable for packing samples.

Samples should be collected in numerical sequence. However it would be helpful if the samples are submitted with no segregation according to types of material. Details of samples, their numbers etc., should be entered into the sampler's field note book in the usual manner.

The sample prefix number for ....is .... This should appear on all sample envelopes.

In regional geochemical reconnaissance carried out in conjunction with the mapping of 1:250,000 Sheet areas, the highest intensity of sample collection should be over those rock types in which mineralization is already known or where there are structural or chemical conditions favourable to the deposition of economic minerals, e.g., faults and unstable shelf zones, contact zones etc. Ideally, the density of sediment and colluvial soil samples over these areas should be approximately 5 samples per square mile. However, with the present rapid rate of coverage in the mapping programme it is unlikely that a geologist and field assistant could collect more than one sample per square mile. Moreover some areas will be devoid of samples either because of difficulty of access or because of the presence of Mesozoic or Cainozoic cappings. Each sampler should aim to collect between 50 and 100 sediment samples per week.

It should be possible for field assistants to do much of the sampling, but they will need close supervision until they are considered thoroughly reliable. If sampling is carried out in a careless manner, without due regard to contamination and the exact location of the sample point, the sample may be useless, or worse, give misleading results.

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 I

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 ASSEMBLAGE IN SOME SEDIMENTARY ROCKS

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

Elements of important minerals in detrital heavy mineral concentrates

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

APPENDIX III

DISTRIBUTION 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.	Carbonates.
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*	7.8*	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	920	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*	0.38*
Cobalt	150	43	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	?	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

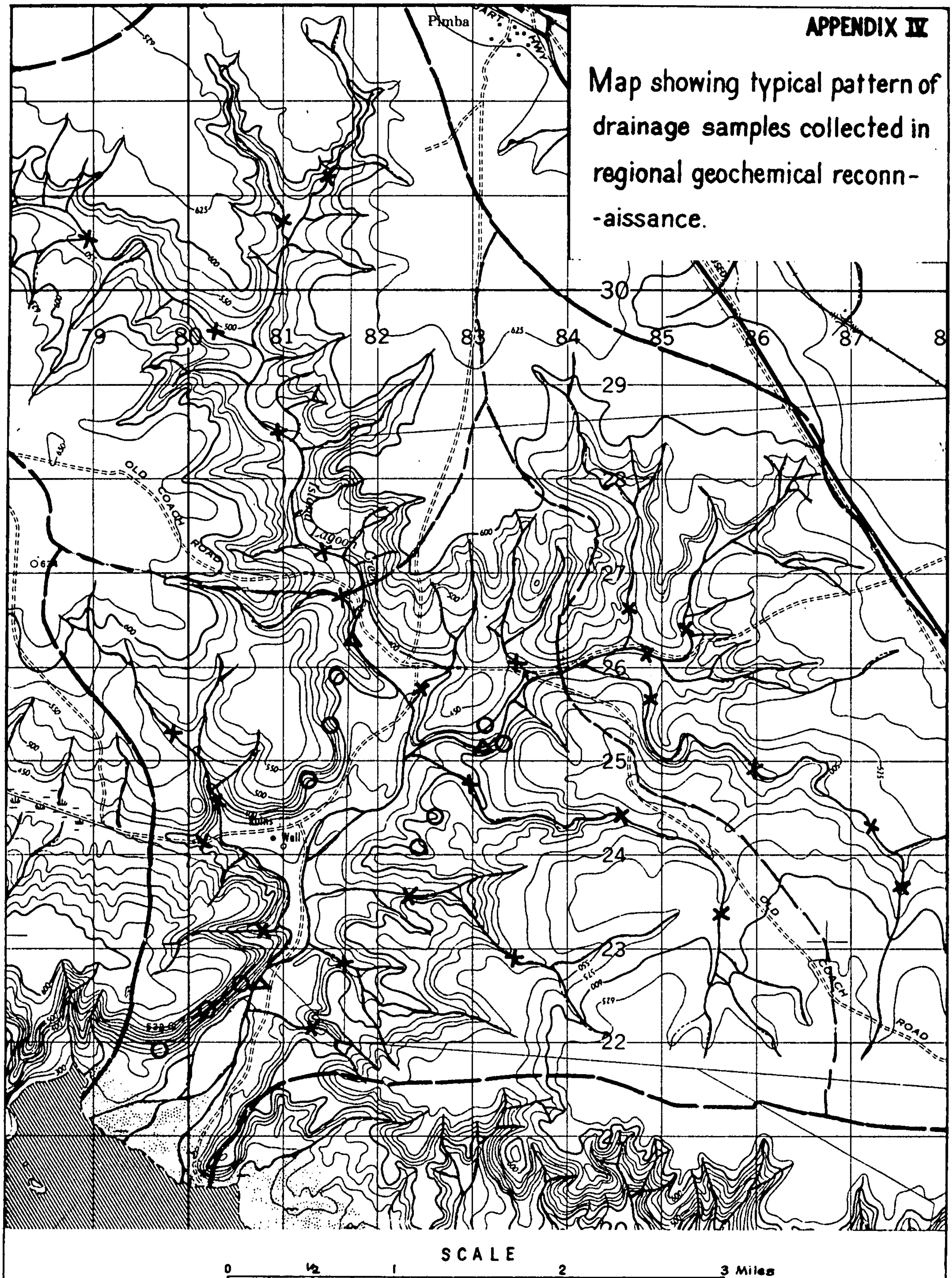
** After Turekian and Wed epohl, Geol.Soc. Amer. Vol.72 1961.

* Figures in per cent.

X Order of magnitude

APPENDIX IV

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



Watershed of main drainage basin.

Boundary of minor drainage basins, within catchment area, each having an area of approximately 10 square miles. Only sediment and alluvium 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 and alluvium 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. *To accompany Record 1964/57* M(M)/61 G.M.

APPENDIX V

ABRIDGED CODE FOR THE RECORDING OF GEOCHEMICAL DATA ON SAMPLE BAG FORMS.

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 geochemical master punch card. A comprehensive code to assist in the recording of data in detail is being prepared by W. Morgan, K.Walker, D.Haldane and A.L.Mather, and will be available for the 1965 field season. Meanwhile, a simplified code has been drawn up for use during the 1964 season. It is very important that these forms are filled in with great care. Incorrectly completed forms may cause considerable delay in the analysis of samples. For field purposes it is only necessary to fill in boxes 2 to 7, 16 to 59, 75 to 80, and in the case of petrological specimens, boxes 60 and 68. The more detailed code for minerals, soils and mineral deposits is intended for special orientation and for laboratory use.

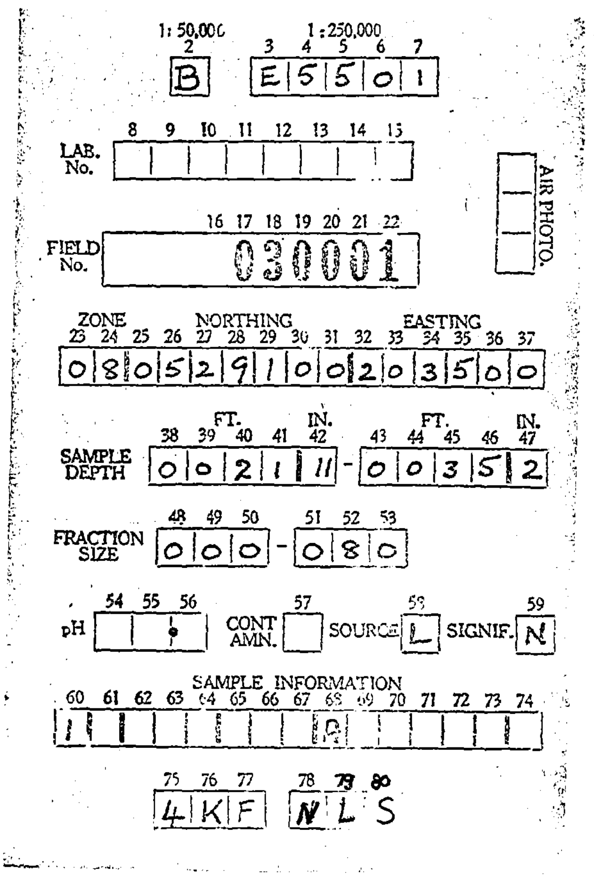


Fig. 1. Form printed on geochemical sample bags.

BOX 2: 1 Mile or 1:50,000 map index.

Coding of 1 mile and 1:50,000 map areas within 4 mile or 1:250,000 scale maps in Australian Index.

1 mile scale map unit →

A	B	C	D	E	F
G	H	I	J	K	L
M	N	O	P	Q	R
S	T	U	V	W	X

1:50,000 scale map unit.

1:250,000 scale map unit.

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

1 mile scale map unit →

A	B	C	D	E	F
G	H	I	J	K	L
M	N	O	P	Q	R
S	T	U	V	W	X
Y	Z	1	2	3	4
5	6	7	8	9	→

1:50,000 scale map unit

1:250,000 scale map unit.

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 will be 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, i.e. A + B, C + D, E + F, G + H etc., represent the 1-mile scale maps at present in use. Thus when giving a sample location on a one-mile map one should give the 1:50,000 map code letter or digit depending whether the sample is on the west or east half of the one-mile map.

BOXES 3 to 7:

1:250,000 map reference. A map number such as SD 55/13 (Cooktown) is coded by omitting the prefix 'S' and the slush thus becoming D5513. SE.55/1 would become E5501 (see Fig.1.)

BOXES 8 to 15:

Laboratory reference number: Boxes 8 to 15 should be left vacant .

BOXES 16 to 22:

Field sample number: This number will be inserted by the field man and will conform to an established field numbering system. A project or personal prefix number will be allocated to party leaders, and sampling groups. This number will be situated in the rectangular box under numbers 16 to 18. The prefix number will be followed by the sample number under box numbers 19 to 22. The first number then, in a project No.3 would be numbered 0030001 (see Fig.1.). For a geologist with personal prefix 123 the first sample number would be 1230001. When 9999 samples have been collected a new prefix number will be allocated by the supervising geologist.

An automatic enumerator should be used for the numbering of sample packets and may be obtained from the B.M.R.Store at Canberra. This enumerator prints six digits only, so first digit should be positioned under number 17 on the packet form. The stamped figures may be accurately centred by aligning the two prongs at the base of the enumerator with the base line of the Field Number box on the packet.

BOXES 23 to 37:

Grid reference: Each sample will be located by means of the Australian grid system or, in the case of the Territory of Papua, New Guinea, by the U.T.M. grid system. For each sample the Zone should be specified in Boxes 23 and 24, the northing co-ordinate in boxes 25 to 31 and the easting co-ordinate in boxes 32 to 37. Even if there is some doubt on the accuracy of plotted sample points, the location of these points should be registered by as full a grid reference as possible. Units should be put in boxes 31 and 37, tens in 30 and 36, hundreds in 29 and 35 - and so on. (see Fig.1). Geologists should make sure that before leaving for the field the grid has been superimposed on all photoscale compilation maps being used for plotting geochemical samples. L shaped reamers can be obtained from the drawing office to facilitate reading of grid reference co-ordinates.

Where geochemical samples are being collected on an arbitrary grid pattern, the origin and one other point, preferably at the end of the base line, should be located in terms of the Australian grid. From these co-ordinates the remainder of the sample points may be calculated with the aid of a computer. Until these are computed, the co-ordinates of the arbitrary grid may be placed in boxes 25 to 37. In this case NO figures should be placed in boxes 23 and 24.

BOXES 38 to 47:

Sample depth. The upper and lower limit of the sample depth are placed in boxes 38 to 42 and 43 to 47, and is shown in feet and inches. In boxes 42 and 47 inches are given (either one or two digits), in boxes 41 and 46, units of feet; in boxes 40 and 45, tens of feet - and so on. (see Fig.1). In the case of inclined drill holes these are treated as vertical samples and the collar of the hole is recorded by grid reference co-ordinates.

BOXES 48 to 53:

Fraction size. Boxes 48 to 50 indicate the coarse fraction size and boxes 51 to 53 the fine fraction size. Thus 100 - 300 would indicate that the fraction between 100 and 300 mesh sizes had been submitted. If the fraction passing through an 80-mesh is submitted, this is shown as 000-080 (see Fig.1.), or in the case of the coarse fraction above 80-mesh it is 080-000.

BOXES 54-56:

pH . pH, the measure of alkalinity or acidity of water sediments or soil is recorded in boxes 54 to 56. The decimal point is situated between boxes 55 and 56.

BOX 57:

Contamination: In this box any of the principal types of contaminant can be recorded. The appropriate number is inserted in the box.

1. Mine dumps.
2. Smelter fumes.
3. Road or rail ballast. (Mine dump material often used.)
4. Industrial and house drainage effluents.
5. Fertilisers, (often contain metal additions or impurities.)

BOX 58:

Source: Write corresponding letter in box.

A. Outcrop
B. Mine
C. Mill or smelter product.
D. Residual soil
E. Valley slope colluvium
F. Stream sediment sample
G. Bank alluvium
J. Erratic
K. Auger sample
L. Rock core sample
M. Drill hole cuttings sample
N. Well product (oil water gas).
P. Heavy mineral concentrate.
Q, Magnetic fraction
Z Volcanic exhalation.

BOX 59:

Sample significance: The alphabet code is subdivided into three groups of five letters; the groups represent the submitter's appraisal of the significance of the sample. If it is a typical sample, one of the A to E applies; if it is a local variant, such as a border zone or an alteration product, it is coded in the J to N group, and if the submitter cannot tell from the field evidence whether the sample is significant or not, it is coded S to W.

Type of sample:

A. to E : Whole of significant rock mass, unit or material etc. at a given place.

J to N : Part of large rock mass or unit with respect to a geological or compositional characteristic.

S to W : Significance with respect to a rock mass not known.

Mode of sampling:

Having established the group of letters that represent the type of sample, a letter from this group is selected according to the mode of sampling.

A. J. S. : Single specimen, purposefully selected.

B. K. T. : Composite specimen, fractions combined quantitatively proportioned to some rock characteristic.

C. L. U. : Composite, fractions combined intuitively.

D. M. V. : Composite, fractions combined in taking (channel sample).

E. N. W. : Composite in nature (e.g. drill cuttings).

BOXES 60 to 74 SAMPLE INFORMATION.

Box 60 : Sample type: The number placed in this box indicates the type of material that will be described in the following boxes 61 to 74.

1. Igneous
2. Metamorphic
3. Sedimentary
4. Minerals
5. Soils
6. Mineral deposits.

Boxes 60 - 74 (Sample types 1 to 3): See Petrological sample code (in preparation). During the 1964 season it will only be necessary to fill in boxes 60 and 68 to briefly describe Igneous, Metamorphic and Sedimentary rocks. For example a granite sample would be coded 1 in box 60 and A in box 68 (see Fig.1.)

BOX 68 Igneous rock (Type 1):

A. Granitic
B. Micro-granitic
C. Granodiorites
D. Micro-granodioritic
E. Rhyolite
F. Rhyolitic glass
G. Syenitic
H. Micro - syenitic
I. Trachytic
J. Diorite
K. Micro-diorite
L. Andesitic
M. Gabbroic
N. Doleritic
O. Basaltic
P. Basaltic glass
Q. Under saturated rocks
R. Ultramafic
S. Acid pegmatite
T. Intermediate pegmatite
U. Basic pegmatite
V. Aplite
W. Pyroclastic

BOX 68 Metamorphic rock (Type 2):

A. Amphibolite
B. Buchite
C. Charnockite
D. Eclogite
E. Gneiss
F. Granofels
G. Hornfels
H. Marble
I. Metaquartzite
J. Migmatite
K. Mylonitic
L. Phyllite
M. Phyllonite
N. Schist
O. Skarn
P. Slate
Q. Spotted slate.

BOX 68: Sedimentary rock (Type 3):

Based on proposed classification by A.R.Jonsen.

CLASTIC - Epiclastic:

Rudite:

A. Conglomerate
B. Paraconglomerate.

Arenite: (including sandstone, greywacke, sub-greywacke and arkose).

C. Quartz arenite i.e. > 75% quartz.
D. Lithic arenite
E. Feldspathic arenite.

Lutite:

F. Mudstone
G. Siltstone
H. Claystone.

Sedimentary rock (type 3) Cont.)

Box 68, (Cont.)

CLASTIC - Pyroclastic:

I. Agglomerate or volcanic breccia

J. Tuff

K. Volcanic conglomerate, arenite or lutite.

CLASTIC - Cataclastic

L. Tillite

NON-CLASTIC - Precipitates

M. Limestone

N. Dolomite

O. Bedded iron deposits

P. Silica deposits

Q. Phosphorite

NON-CLASTIC - Evaporites

R. Halite

S. Gypsum

T. Anhydrite

HYBRIDS

U. Hybrids within clastic rocks, e.g. tuffaceous sandstone and sandy tuffs.

V. Hybrids of clastic and non-clastic rocks e.g. sandy limestones and calcareous sandstones.

W. Hybrids within non-clastic rocks

MINERALS (BOX 60 - Type 4.)

Boxes 61 - 62 (Box 60 sample type 4) Dana class number.

The one or two digits preceding the individual chemical groups below are placed in boxes 19 and 20. In groups 1 to 9 the single digit is put in box 20.

1. Native elements
2. Sulphides
3. Sulphosalts
4. Simple oxides
5. Oxides contining U, Th, and Zr.
6. Hydroxides and Oxides containing hydroxyl.
7. Multiple Oxides
8. Multiple Oxides containing Nb, Ta, and Ti.
9. 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 " "
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, cont. hydroxyl or halogen.
42. Hydrated phosphate etc. containing hydroxyl.
43. Compound Phosphates etc.

Boxes 61 - 62 Cont.)

MINERALS - Dana class number (Cont.)

44. Antimonites
45. Acid and Normal Antimonites and Arsenites.
46. Basic or Halogen - cont. 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.

Boxes 63 - 67 : Mineral name code

Use a five letter code - first letter and following four consenants (delete a, e, i, u, y) unless entire name is $\leq$ five letters, if less than four consonants in name leave blanks on right.

SOILS:

Box 61 (Box 60 type 5 - soils) · Soil Type - Undifferentiated.

1. Alluvial soils
2. Skeletal soils
3. Calcareous coastal sands
4. Wind blown dust and sand

Box 62 (Box 60 type 5 - soils) : Soil Type - Pedalfers.

1. Soil domonated by acid peat or peaty alluvial horizon, e.g. moor peats, alpine humus soils, moor podsol peats and acid swamp soils.

2. Soil acid and with organic, sesquioxide and sometimes clay illuvial horizons, e.g. podzols and ground water podzóls.

3. Soil acid and with clay and sesquioxide illuvial horizons, e.g. laterites, greybrown, brown, red, yellow and non-calcic podzols.

4. Soil acid to neutral and lacking pronounced eluviation of clay, e.g. yellow earths, krasnozens lateritic krasnozens, lateritic red earths, terra rossa and prairie soils.

* Metasilicates Division.

BOX 63 (Box 60 type 5- soils) : Soil Type - Pedocals

1. Soil dark coloured and slightly acid to neutral in eluvial horizons, calcareous illuvial horizons, e.g. black earths, wiesenboden, brown forest soils, rendzines, ground water and fom soils.

2. Soil saline or showing peat 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 or 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 hardpan soils, desert plain soils, calcareous laterite soils and stony desert tableland soils.

Box 64 (Box 60 to type 5- soils) Soil horizon.

1. Aoo Horizon
2. Ao "
3. A1 "
4. A2 "
5. B1 "
6. B2 "
7. C "

Box 65 (Box 60 type 5 - soils) : Parent material - igneous rock.

Same as for Box 68 (type 1). See page 5.

Box 66 (Box 60 type 5 - soils) : Parent material - metamorphic rock.

Same as for Box 68 (type 2). See page 5.

Box 67 (Box 60 type 5 - soils) : Parent material - sedimentary roxk.

Same as for Box 68 (type 3). See page 5.

Box 68 (Box 60 type 5 - soils) : Topography.

1. Flat
2. Rolling
3. Steep
4. Very steep
5. Broken and irregular.

Box 69 (Box 60 type 5 - soils) : Rainfall.

1. 0 - 5 inches per year.
2. 5 - 10 "
3. 10 - 20 "
4. 20 - 30 "
5. 30 - 40 "
6. 40 - 50 "
7. 50 - 60 "
8. 60 - 80 "
9. 80 - 100 "

\+ Over 100 "

Soils (Cont.)

Box 70 (Box 60 type 5 soils) : Soil minerals and other soil components.

A.	Quartz	K.	Muscovite
B.	Orthoclase	L.	Biotite
C.	Albite	M.	Chlorite
D.	Oligoclase	N.	Haematite
E.	Labradorite	O.	Limonite
F.	Anorchite	P.	Clay
G.	Apatite	Q.	Ferruginous gravel
H.	Magnetite	R.	Aluminous gravel
I.	Amphiboles and pyroxenes.	S.	Siliceous gravel
J.	Olivine	T.	Organic matter

MINERAL DEPOSITS (Box 60 - Type 8)

BOX 61 (Sample type mineral deposits) : Mineral Deposits.

A - I	Gangue	E.N.W.5.	Silicate
J - R	Altered wall rock	F.O.X.6	Carbonate
S - +	Mineralised sample	G.P.Y.7	Phosphate, vanadator arsenate, antimonate.
1 - 9	Other	H.Q.Z.8.	Uranium compound
A. J. S. 1.	Sulphide or Sulphosalt	I.Z.+.9.	Carbon compound not a carbonate.
B. K. T. 2.	Oxide, hydroxide	O.	Other.
C. L. U. 3	Sulphate.		

Box 62 (Sample type mineral deposits) : Major product metallic.

A.	Pb - Zn	L.	Au
B.	Cu - Mo	M.	Ag
C.	U - V	N.	As - Sb
D.	Fe - Mn	O	Hg
E.	Al - Mg	P.	Bi
F.	W	Q	Be
G.	Cu	R	Se - Te
H.	Co - Ni	S	Rare earths
I.	Th	T.	Platinum group
J.	Sn	U	Others.
K.	Cr.		

Box 63 (Sample type = mineral deposit) : Major product non-metallic.

A.	Abrasives and Refractories	L.	Barium minerals
B.	Industrial clays - bentonite, Fullers Earth, china, filler pigment, diatomite, bloating etc.	M.	Strontium minerals
		N.	Talc and soapstone
		O.	Zirconium - Hafnium
		P.	Titanium minerals
C.	Silica	Q.	Unconsolidated PO_4
D.	Asbestos	R.	Consolidated PO_4
E.	Borates	S.	Lime
F.	Feldspar	T.	Mica
G.	Potash	U.	Nb - Ta
H.	Rare alkalies Li, Rb. Cs.	V.	Zeolites.
I.	Light weight aggregate-perlite, vermiculite, sintered shale etc.	W.	
		X.	
J.	Cement	Y.	
K.	Sulphur.	Z.	Other

Box 64 (Sample type 6 mineral deposits) Minor product (metallic).

Use same code as major product - metallic.

Box 65 (Sample type 6 mineral deposits) Mineral product (non-metallic)

Use same code as major product non-metallic.

Box 66 (Sample type 6- mineral deposits) Genetic type.

0. Magmatic segregation
1. Regional metamorphic
2. Contact metamorphic
3. Replacement
4. Cavity and fracture filling.
5. Sedimentary precipitate
6. Evaporite
7. Mechanical concentrate
8. Residual concentrate
9. Other.

Box 67 (Sample type - mineral deposits) Form of deposit.

0. Tabular concordant
1. Tabular cross cutting
2. Blanket
3. Pipe
4. Irregular
5. Stockworks
6. Massive
7. Local segregations
8. Disseminated
9. Other

Box 75 : Era and Major Group.

0. Quaternary
1. Tertiary
2. Cainozoic
3. Mesozoic
4. Permo-Triassic
5. Palaeozoic
6. Upper Palaeozoic
7. Lower Palaeozoic
8. Proterozoic
9. Archaean
- Pre-Cambrian.

Box 76 : Period.

A.	Recent	L.	Carboniferous
B.	Pleistocene	M.	Devonian
C.	Pliocene	N.	Silurian
D.	Miocene	O.	Ordovician
E.	Oligocene	P.	Cambrian
F.	Eocene	Q.	Upper Proterozoic
G.	Palaeocene	R.	Middle Proterozoic
H.	Cretaceous	S.	Lower Proterozoic
I.	Jurassic	T.	Archaean
J.	Triassic	U.	Pre Cambrian
K.	Permian		

Box 77 to 80 : Formation name.

The first letter and the three succeeding consonants of the geographical part of the name form the code; the lithological part is omitted. The letters A.E.I.O.U.W and Y are to be regarded as vowels. Examples of coding:

Finlayson Granite : FNLS (See Fig.1.)
Laura Sandstone : LR (in columns 77 and 78)
Hodgkinson Formation : HDGK . Almaden Granodiorite : ALMD.