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PAPER 73-36

STUDIES IN "STANDARD SAMPLES" OF SILICATE ROCKS AND MINERALS PART 3: 1973 EXTENSION AND REVISION OF "USABLE" VALUES

(Report and 3 tables)

Sydney Abbey

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1973

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DEPARTMENT OF ENERGY, MINES AND RESOURCES

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ABSTRACT

An earlier review of the state of international reference samples of silicate rocks and minerals has been brought up to date by the addition of new data and correction of errors. New "usable" values of varying degrees of reliability, calculated on the "dry basis" are assigned where possible for major, minor and trace elements in 34 samples. Values are also compared with those listed in other compilations.

RÉSUMÉ

On a mis à date une étude sommaire déjà publiée sur l'état actuel d'échantillons de roches et de minéraux silicatés proposés comme standards internationaux, en ajoutant des données nouvelles et en corrigeant des erreurs. On suggère des nouvelles valeurs dont on peut se servir à divers niveaux de certitude, basées sur la condition "sèche", pour des éléments majeurs, mineurs et en traces dans 34 échantillons. On fait aussi une comparaison des valeurs avec celles présentées dans d'autres publications.

STUDIES IN "STANDARD SAMPLES" OF SILICATE ROCKS AND MINERALS
PART 3. 1973 EXTENSION AND REVISION OF "USABLE" VALUES[1]

INTRODUCTION

In earlier communications (Abbey, 1970, 1972), it was pointed out that the potential users of so-called standard samples of silicate rocks and minerals are faced with a bewildering array of analytical data for each component of each sample. Not only are the results from different laboratories widely scattered in magnitude, but the manner of interpreting the data varies considerably among the compilations published by the various originators of the samples.

There has been an unfortunate tendency by some workers to accept, uncritically, the grand average of all reported results for a given component of a given sample as a "recommended value". Such values may appear acceptable in dealing with most of the usual major and minor components of those samples which do not depart from "usual" compositions, and where the distribution of results for each component is more or less normal. However, in some cases, particularly with samples showing unusual composition patterns, the distribution of values for some components shows strong bias, frequently reflecting inadequacies in analytical methods. In such cases, a crude average can be very misleading.

An interesting example concerns the sodium oxide content of the U.S. Geological Survey dunite, DTS-1. In his first compilation, Flanagan (1969) listed values ranging from 0.00 to 0.27 per cent, with a heavy bias toward the lower values. The crude average was about 0.05 per cent. After a purely subjective elimination of some values, Abbey (1970) suggested 0.01 per cent. Flanagan (1973) recommended 0.007 per cent, without explaining how that value was derived. These two values must be considered as essentially equal, as it is customary in rock analysis to report percentage of major and minor elements to two decimal places. In any case, use of the original crude average sodium oxide values would introduce a relative error of at least 400 per cent.

It was intended to restrict the samples included in this study to those meeting the requirements laid down in Part 2 (Abbey, 1972), but several exceptions have been made. Thus space has been provided in Table I for any data that may be forthcoming in the future concerning certain Canadian, British and Soviet samples. Also included are some East German samples, for which much information has been published, but with which the laboratories of the Geological Survey of Canada have had little experience.

In Part I of this series (Abbey, 1970), suggested values were derived for the major and minor components of six samples from the U.S. Geological Survey, by a process of selective elimination of some reported values, based mainly on the overall performance of the reporting laboratories. In later studies on results for trace elements, it was decided that the values available were generally not sufficiently concordant to justify as selective a treatment as that applied to the major and minor elements. An arbitrary procedure was then adopted and applied to samples from many sources, both in Part 2 (Abbey, 1972) of this series and in this paper. Where 10 or more results are available for a given trace element in a particular sample, the procedure involves using the mean of the remaining values after eliminating the 20 per cent of the results which are farthest removed from the mean of all of the available results. Where five to nine results are available, a crude average is reported, followed by a question mark to indicate uncertainty. Where fewer than five

[1] References Abbey (1970, 1972) may be considered as Parts 1 and 2, respectively, of this series, although not so numbered.

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results are available, no value is listed. Question marks are also used to indicate values that are doubtful for other reasons.

Since Part 2 (Abbey, 1972) appeared, additional data have been received from several sources, and a number of errors have been corrected. It is now therefore possible to list "usable" values for many components of 29 samples, as well as less complete information on several others. The samples are arranged in Table 1 more or less in geographic order, based on the country of origin, starting with Canada. Values listed are those recommended by the originators, where available, exceptions being explained in the following descriptive paragraphs. Where no recommended values are available, the listed values have been derived by one or another of the procedures outlined above and in Part 2, with exceptions also explained in the descriptive paragraphs.

Some compilations published by originators of reference samples have reported analytical data based on the sample "as received". Others have reported on the "dry basis", i.e. after the sample has been dried to constant weight at approximately 110°C. In this work, it was decided to reduce all data to the "as dried" state, in order to compare all samples on a presumably reproducible basis. The calculation, where required, was based on the H_2O^- values listed in Part 2 of this series.

For major and minor elements, results are given to two decimal places, the conventional practice in rock analysis. Exceptions are made where the originators reported to only one place, or where uncertainty indicates that additional significant figures are not justified. Trace elements are, in general, rounded to no more than two significant figures, a 5 or a 0 being accepted in the third place where the first figure is unity.

In Table 1, the major and minor elements are listed for each sample. The components are listed in the same order as in Part 2 (Abbey, 1972), but zirconium, niobium and total rare-earths have been added to the list of major and minor elements, as they are present to a significant degree in some samples.

Table 2 gives the same information as Table 1, but with values arranged in descending order of concentration for each major and minor component. Table 2 also includes data, shown with question marks, for samples whose values are not considered to be sufficiently well established to justify their being listed in Table 1.

Table 3 gives the data for trace elements, in alphabetical order of chemical symbols, and arranged in much the same way as the data in Table 2.

CSRM - Canadian Standard Reference Materials Project

(Contact: Dr. A.H. Gillieson, Co-ordinator, c/o Mines Branch, Department of Energy, Mines and Resources, 555 Booth St., Ottawa, Ont., Canada, K1A 0G1).

No new compilations have become available since Part 2 appeared. Space is provided in Table 1 for possible future data on samples SY-2 and SY-3, as it is understood that collaborative analysis by a small group of laboratories is being planned.

USGS - United States Geological Survey

(Contact: F.J. Flanagan, Liaison Officer, Geological Survey, U.S. Department of the Interior, Washington, D.C. 20244, U.S.A.).

Although his earlier compilation (Flanagan, 1969) listed merely individual results and crude averages, Flanagan's latest compilation (Flanagan, 1973) gives three categories of values - "recommended", "average" and "magnitude", on the U.S. Geological Survey samples and a number of others. No explanation is given regarding how the recommended values were derived on the American samples, nor why only averages or magnitudes are reported in some cases. (For samples from other sources, it is presumed that Flanagan categorized the results on the

basis of the originators' reports, some of which are far from consistent.)

There were some discrepancies between Flanagan's (1973) "recommended" values and the "usable" values in Part 2 (Abbey, 1972). In general, Flanagan's recommended values were given precedence over our own "usable" values, and his "average" values over those of our own values which appeared with question marks. Exceptions were made in favor of our own values where those listed by Flanagan involved contradictions (e.g. mutual incompatibility of ferrous, ferric and total iron), unusually high summations (e.g. where chromium and nickel are included for DTS-1 and PCC-1), or apparent errors (e.g. H_2O^- in AGV-1).

A few examples will indicate some of the pitfalls encountered in arriving at assigned values, be they "recommended", "average", "magnitude" or whatever. Laboratories which use purely instrumental methods would normally report total iron content, expressed as Fe_2O_3. Those using more purely chemical procedures would more likely determine total iron and ferrous iron, calculating ferric iron by difference, using the appropriate corrections for differences in formula weight between FeO and Fe_2O_3. In a compilation of many results, data from both types of analyses would likely be involved. If values are assigned to the three iron oxide concentrations by merely treating each as a separate determination, contradictions can easily arise. However, if some selective procedure is applied to results for all three iron oxide concentrations, it is possible to arrive at more concordant relationships and thereby to inspire more confidence in the assigned values. The following data on sample USGS-DTS-1 will illustrate the point:

	Flanagan (1973)	Abbey (1972)
FeO, pct	7.23 ("average")	6.98 ("usable")
Fe_2O_3	1.21 ("recommended")	0.85 ("usable")
Fe_2O_3T, calculated	9.24	8.51
Fe_2O_3T, reported	8.64 ("recommended")	8.59 ("usable")

("Fe_2O_3T" means "total iron, expressed as Fe_2O_3").

Aside from the discrepancy in Flanagan's data, there is the question of how a "recommended" value for ferric oxide could be arrived at, when individual ferric values are derived from individual ferrous and total iron values, and no recommended value is listed for ferrous iron. Similar discrepancies occur with sample USGS-PCC-1.

Flanagan (1973) lists a SUM of 99.86 per cent for USGS-DTS-1, but that summation accounts for only the major and minor components usually determined in a "complete" rock analysis. The sample, unfortunately, includes high concentrations of chromium and nickel. If those elements are expressed as the conventional oxides and added to Flanagan's SUM, the new total is much too high.

The values listed for the U.S. Geological Survey samples in this work have been re-calculated to the dry basis. A similar calculation was made for other samples previously listed in the "as received" state.

Flanagan (1973) reported that samples W-1 and DTS-1 are no longer available, but data for those samples are included in this work for the sake of continuity.

NBS - National Bureau of Standards

(Contact: Office of Standard Reference Materials, Room B314, Chemistry Building, National Bureau of Standards, Washington, D.C. 20234, U.S.A.).

Material listed is identical to that in Part 2.

BCS - British Chemical Standards

(Contact: Bureau of Analyzed Samples, Newham Hall, Middlesborough, England).

Material listed is identical to that in Part 2.

QMC - Queen Mary College

(Contact: Dr. A.B. Poole, Department of Geology, Queen Mary College, Mile End Road, London, E. 1, England).

To our knowledge no compilation of data has as yet been published for the four samples from this source. Space is provided in the tables for possible future data, although the Geological Survey of Canada laboratories have had no experience with the samples at this writing.

ANRT - Association Nationale de la Recherche Technique
CRPG - Centre de Recherches Pétrographiques et Géochimiques

(Contact for both groups: K. Govindaraju, Centre de Recherches Pétrographiques et Géochimiques, Case officielle no. 1, 54500 Vandoeuvre-lès-Nancy, France).

Sufficient additional data have been received on ANRT samples DR-N and UB-N to justify their inclusion in Table 1 (de la Roche and Govindaraju, 1972). There is a discrepancy in the case of MgO in UB-N. The originators recommend a value of 35.00 per cent on the basis of repeated analyses by a select group of laboratories, although both the overall average and the "preferred mean" suggest a value about 0.5 per cent higher. The question mark after the value 35.0 in Tables 1 and 2 is due to that discrepancy.

In another paper (de la Roche and Govindaraju, 1973), analytical data are presented for a synthetic glass, VS-N, to which known amounts of numerous "trace elements" have been added. The analytical data indicate a substantial degree of recovery of the added elements. Unfortunately, most of those elements are at the 1000- or 500-ppm level, which is rather high for many elements. More useful working standards can presumably be prepared by dilution with "pure" glass, containing known, small concentrations of the trace elements, assuming such material to be available. The fact that all of the trace elements have been added to a single standard is a disadvantage, because all would be diluted in essentially the same proportion, resulting in the possibility that inter-element interferences may go unnoticed. The originators' recommended values are listed in Table 3, as are also their "proposed" values, the latter being identified by a question mark. Major and minor elements are reported by the originators, but they are not intended for use as standards, and are accordingly not listed in Tables 1 and 2.

Values for three of the CRPG standards (BR, GA and GH) are only slightly changed from those listed in Part 2 (cf Roubault, et al., 1970), but they have been re-calculated to the dry basis. "Mica Fe" is still not considered as good a standard as the three others, and its values are therefore listed only in Tables 2 and 3, as are also those for "Mica Mg". All values for both micas are given with question marks, although some of them may be quite acceptable.

ZGI - Zentrales Geologisches Institut

(Contact: Zentrales Geologisches Institut, Invalidenstrasse 44, 104 Berlin, Deutsche Demokratische Republik).

At this writing, our laboratories have had very little experience with the East German samples. Some of them have, however, been included in this work because they represent typical silicate rock compositions, their values appear to be well established, and a number of European and North American Laboratories have reported data on them.

Values given in the tables are those listed by the originators (Schindler, 1972; Grassman, 1972). It was not possible to apply a selective procedure for arriving at usable values because the originators did not list individual results. For major and minor elements, they gave means, numbers of determinations, standard deviations and 95% confidence limits. Exceptions were made for silica and alumina, where adjusted values were recommended. The confidence limits on the other components are such as to indicate that the listed

values may be considered as "usable". For the trace elements, the values given in Table 3 are the means listed by the originators, a question mark indicating that the mean was based on five to nine results. For those values based on 10 or more results, absence of data on individual results precluded elimination of outlier values.

Two ZGI samples, limestone KH and anhydrite AN, are not included in this work because their compositions are far removed from those of silicate rocks. The limited available data on shale TS and feldspar sand FK are listed with question marks in Table 2.

Len - Leningrad State University

(Contact: Prof. A.A. Kukharenko, Department of Mineralogy, Leningrad State University, Leningrad V-164, U.S.S.R.).

The nepheline syenite sample, listed here as Len-NS-1, is known to the originators as "Khibinii Generalnaya". The data presented here are the same as in Part 2, except that they have been re-calculated to the dry basis.

IGI - Institute of Geochemistry, Irkutsk

(Contact: Prof. L.V. Tauson, Institute of Geochemistry, P.B. 701, Irkutsk 33, U.S.S.R.).

No data are available on the three samples from this source, trap IGI-2001, gabbro IGI-2003 and albitized granite IGI-2005, but space is provided in Table 1 for future use.

GSJ - Geological Survey of Japan

(Contact: Dr. Atsushi Ando, Geochemical Research Section, Geological Survey of Japan, 135 Hisamoto-cho, Kawasaki-shi, Japan).

The data in the tables are the same as in Part 2, except that they have been re-calculated on the dry basis.

MRT - Mineral Resources, Tanzania

(Contact: Commissioner, Mineral Resources Division, P.O. Box 903, Dodoma, Tanzania).

The values in the tables are unchanged from Part 2.

NIM - National Institute of Metallurgy

(Contact: H.P. Beyers, South African Bureau of Standards, Private Bag 191, Pretoria, South Africa).

A detailed study was undertaken of the raw data provided in the compilation which appeared in 1972 (Russell et al., 1972), using the same general approach as used on the American samples in Part 1. It soon became apparent that difficulties would arise because of the unusual compositions involved, such as high concentrations of chlorine, manganese, strontium, zirconium and niobium in NIM-L; unusually high potassium and barium in NIM-S; and unusually high chromium in NIM-P.

These unusual compositions provided pitfalls for some unwary analysts. For example, those laboratories that did not determine strontium in NIM-L, reported relatively high values for calcium where that element was determined by purely chemical methods (oxalate precipitation, EDTA titration, etc.). The high chromium, niobium, rare-earth and zirconium contents caused similar difficulties with alumina determinations. A considerably greater degree of subjective judgment was therefore required in arriving at "usable" values, and it must be

recognized that those values are probably not as reliable as those derived for the American samples.

Careful study of Flanagan's (1973) figures reveals discrepancies for the different iron oxide values in some of the South African samples, similar to those observed with two of the U.S.G.S. samples. Further, the very high zirconium content of NIM-L and the very high chromium content of NIM-P have apparently been overlooked in Flanagan's tables. Those tables list none of the data on the South African samples as "recommended" values, but there is the danger that their limited reliability may not be recognized by those who use the tables. The selective procedure used in this work has led to more compatible iron oxide values and summations.

PRECAUTIONARY NOTES REGARDING THE TABLES

Considerable difficulty was encountered in this work because of the uncertainty of the meanings of such words as "certified", "guaranteed", "accepted", "recommended", "proposed", "preferred", "average", etc., as applied by different authors to their listed values, particularly where translation from French, German or Russian was involved. It is therefore difficult to describe the relative reliability of the data on the various groups of samples. This work, like Part 2, therefore uses the term "usable" for the tabulated values, indicating that they can be used for most purposes, but that more detailed information about their reliability can be obtained only by careful study of the original compilations and of the results included in them. In a general way, it can be said once again that "values listed without qualifications are believed to be sufficiently well established that significant changes are not likely to result from future compilations. Values given with a question mark are less certain ..." (Abbey, 1972).

In the tables, Fe_2O_3T means "total iron content, expressed as ferric oxide"; RE_2O_3T means "total rare earth oxides"; and SUM has been corrected for fluorine, sulphur and chlorine.

In order to avoid misunderstanding, readers are urged to read the text of this paper before using any of the tables. Readers are also requested to draw the author's attention to any errors observed in the text or tables.

ACKNOWLEDGMENT

The author is indebted to F.J. Flanagan for providing advance information on his 1972 compilation, to A.H. Gillieson for advance information on proposed collaborative analysis of samples SY-2 and SY-3, and to J.A. Maxwell for critical reading of the manuscript.

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TABLE 1

"Usable" Values, Major and Minor Elements (per cent, dry basis)*

	CSRM			USGS						
	MRG-1	SY-2	SY-3	AGV-1	BCR-1	DTS-1	G-2	GSP-1	PCC-1	W-1
SiO_2	See TABLE 2	No published compilation		59.72	54.85	40.68	69.19	67.31	42.15	52.72
Al_2O_3				17.22	13.68	0.29	15.35	15.19	0.73	14.87
Fe_2O_3T				6.84	13.52	8.60	2.67	4.33	8.28	11.11
MgO				1.55	3.49	49.83	0.77	0.96	43.63	6.63
CaO				5.00	6.98	0.15	1.98	2.02	0.53	10.98
Na_2O				4.31	3.29	0.01	4.06	2.80	0.01	2.15
K_2O				2.93	1.68	0.00	4.52	5.53	0.00	0.64
TiO_2				1.05	2.22	0.01	0.50	0.66	0.01	1.07
MnO				0.10	0.19	0.11	0.04	0.04	0.12	0.17
BaO				0.14	0.08	0.00	0.21	0.15	0.00	0.02
SrO				0.08	0.04	0.00	0.06	0.03	0.00	0.02
Cr_2O_3				0.00	0.00	0.64	0.00	0.00	0.44	0.02
NiO				0.00	0.00	0.31	0.00	0.00	0.32	0.01
ZrO_2				0.03	0.02		0.04	0.07		0.01
Nb_2O_5										
RE_2O_3T				0.02?	0.02?		0.04?	0.10?		0.01?
FeO				2.08	9.05	6.98	1.45	2.31	5.17	8.73
Fe_2O_3				4.57	3.48	0.85	1.01	1.77	2.50	1.40
H_2O^+				0.82	0.73	0.46	0.55	0.57	4.64	0.53
CO_2				0.01	0.03?	0.06	0.08	0.12	0.16	0.06
P_2O_5				0.50	0.33	0.00	0.14	0.28	0.00	0.14
Cl				0.02	0.01	0.01?	0.01	0.04	0.01?	0.02?
F				0.04?	0.05?	0.00	0.14	0.39	0.00	0.02
S				0.01?	0.04?	0.00	0.00?	0.04	0.01	
SUM				100.15	100.19	100.39	100.08	100.17	100.43	100.19

*See "Precautionary Notes ...", p. 6.

(cont'd...)

TABLE 1 (continued)

"Usable" Values, Major and Minor Elements (per cent, dry basis)*

	NBS		BCS		QMC			
	70a	99a	375	376	I-1	I-2	M-2	M-3
SiO_2	67.1	65.2	67.1	67.1				
Al_2O_3	17.9	20.5	19.8	17.7				
Fe_2O_3T	0.08	0.06	0.12	0.10				
MgO		0.02	0.05	0.03				
CaO	0.11	2.14	0.89	0.54				
Na_2O	2.55	6.2	10.4	2.83				
K_2O	11.8	5.2	0.78	11.2				
TiO_2	0.01	0.01	0.38	0.01?				
MnO								
BaO	0.02	0.26						
SrO								
Cr_2O_3								
NiO								
ZrO_2								
Nb_2O_5								
RE_2O_3T								
FeO								
Fe_2O_3								
H_2O^+								
CO_2								
P_2O_5		0.02						
Cl								
F								
S								
SUM	99.57	99.61	99.52	99.51				

No published compilation

*See "Precautionary Notes ...", p. 6.

(cont'd...)

TABLE 1 (continued)

"Usable" Values, Major and Minor Elements (per cent, dry basis)*

	ANRT		CRPG				
	DR-N	UB-N	BR	GA	GH	Mica Fe	Mica Mg
SiO_2	52.87	39.93	38.39	69.96	75.85		
Al_2O_3	17.56	2.97	10.25	14.51	12.51		
Fe_2O_3T	9.69	8.45	12.98	2.86	1.33		
MgO	4.47	35.0?	13.35	0.95	0.03		
CaO	7.09	1.18	13.87	2.45	0.69		
Na_2O	3.00	0.10?	3.07	3.55	3.85		
K_2O	1.73	0.02?	1.41	4.03	4.76		
TiO_2	1.10	0.12	2.61	0.38	0.08		
MnO	0.21	0.12	0.20	0.09	0.05		
BaO	0.04	0.00	0.11	0.10	0.00		
SrO	0.05	0.00	0.16	0.04	0.00		
Cr_2O_3	0.01	0.33	0.06	0.00	0.00		
NiO	0.00	0.25	0.03	0.00	0.00		
ZrO_2	0.02		0.03	0.02	0.02		
Nb_2O_5			0.01?		0.01?		
RE_2O_3T			0.01?	0.01?	0.01?		
FeO	5.32	2.69	6.60	1.32	0.84		
Fe_2O_3	3.78	5.46	5.61	1.36	0.41		
H_2O^+	2.20	11.28	2.31	0.87	0.46		
CO_2	0.15?	0.44?	0.86	0.11	0.14		
P_2O_5	0.25	0.03	1.05	0.12	0.01		
Cl			0.04?	0.03	0.01?		
F			0.10	0.05	0.30		
S			0.04?	?	?		
SUM	99.85	100.36	100.09	99.92	99.90		

See TABLE 2

*See "Precautionary Notes ...", p. 6.

(cont'd...)

TABLE 1 (continued)

"Usable" Values, Major and Minor Elements (per cent, dry basis)*

	ZGI					Len	IGI		
	BM	FK	GM	TB	TS	NS-1	2001	2003	2005
SiO_2	49.60		73.55	60.30		53.41			
Al_2O_3	16.20		13.50	20.55		21.30			
Fe_2O_3T	9.68		2.02	6.92		4.13			
MgO	7.46		0.38	1.94		0.63			
CaO	6.44		1.02	0.30		1.72			
Na_2O	4.64		3.76	1.31		9.86			
K_2O	0.20		4.74	3.85		6.51			
TiO_2	1.14		0.21	0.93		1.06			
MnO	0.14		0.04	0.05		0.19			
BaO	0.03		0.04	0.08		0.13?			
SrO	0.03		0.02	0.02		0.15?			
Cr_2O_3	0.02		0.00	0.01		0.00			
NiO	0.01		0.00	0.01		0.00			
ZrO_2	0.01		0.02	0.02		0.09			
Nb_2O_5									
RE_2O_3T	0.01?		0.02?	0.03?		0.06?			
FeO	7.28		1.14	5.43		1.58			
Fe_2O_3	1.60		0.75	0.91		2.38			
H_2O^+	3.62		0.35	3.82		0.65			
CO_2	1.34?		0.28?	0.13		0.14			
P_2O_5	0.10		0.06	0.10		0.28			
Cl	0.01?		0.01?	0.00					
F	0.03?		0.07?	0.07?		0.14			
S						0.02			
SUM	99.89		99.93	99.83		100.24			

See TABLE 2

See TABLE 2

No published compilation

*See "Precautionary Notes ...", p. 6.

(cont'd...)

TABLE 1 (continued)

"Usable" Values, Major and Minor Elements (per cent, dry basis)*

	GSJ		MRT	NIM					
	JB-1	JG-1	T-1	-D	-G	-L	-N	-P	-S
SiO_2	52.61	72.31	62.69	38.97	75.73	52.66	52.65	51.18	63.54
Al_2O_3	14.67	14.22	16.57	0.26	12.13	13.57	16.47	4.27	17.16
Fe_2O_3T	9.13	2.21	5.94	16.99	1.96	9.95	8.95	12.78	1.44
MgO	7.78	0.73	1.86	43.68	0.05?	0.23	7.56	25.35	0.48
CaO	9.30	2.18	5.11	0.26	0.77	3.19	11.47	2.67	0.68
Na_2O	2.82	3.39	4.40	0.06?	3.36	8.35	2.47	0.38	0.41
K_2O	1.43	3.96	1.24	0.02	5.04	5.52	0.25	0.09	15.40
TiO_2	1.35	0.26	0.59	0.02	0.09	0.49	0.20	0.20	0.05
MnO	0.16	0.06	0.11	0.21	0.02	0.76	0.18	0.22	0.01
BaO	?	?	0.07?	0.00	0.02?	0.05	0.01	0.01	0.27
SrO	0.05	0.02	0.05?	0.00	0.00	0.54	0.03	0.00	0.01
Cr_2O_3	0.06?	0.00	0.00	0.41	0.00	0.00	0.01	3.62	0.00
NiO	?	0.00	0.00	0.29	0.00	0.00	0.02	0.07	0.00
ZrO_2			0.02	0.00	0.04	1.63	0.00	0.00	0.00
Nb_2O_5				0.00	0.00	0.12?	0.00	0.00	0.00
RE_2O_3T					0.04?	0.05?			
FeO	6.12	1.66	2.91	14.67	1.30	1.04	7.49	10.47	0.29
Fe_2O_3	2.32	0.36	2.80	0.70	0.63	8.76	0.62	1.12	1.08
H_2O^+	1.01	0.53	1.51	0.26	0.42	2.44	0.31	0.25	0.23
CO_2	0.19?	0.09?	0.08?	0.42?	0.08?	0.21?	0.10?	0.08?	0.10?
P_2O_5	0.26	0.10	0.14	0.03	0.02	0.07	0.04	0.02	0.14
Cl				0.04?	0.06?	0.11?	0.01?	0.01?	0.02?
F	?	?	0.06?	0.00	0.43?	0.43?	0.04?	0.02?	0.02?
S			0.01?	0.00	0.01?	0.06	0.01?	0.01?	0.01?
SUM	100.13	99.87	100.18	100.29	100.04	100.02	99.91	100.02	99.88

*See "Precautionary Notes ...", p. 6.

TABLE 2

"Usable" Values - Arranged by Major and Minor Components*

SiO_2		Al_2O_3		Fe_2O_3T		MgO	
88.2	FK	21.30	NS-1	25.8?	Mica Fe	49.83	DTS-1
75.85	GH	20.55	TB	?	MRG-1	43.68	NIM-D
75.73	NIM-G	20.5	99a	16.99	NIM-D	43.63	PCC-1
73.55	GM	19.8	375	13.52	BCR-1	35.0?	UB-N
72.31	JG-1	19.4	Mica Fe	12.98	BR	25.35	NIM-P
69.96	GA	17.9	70a	12.78	NIM-P	20.4?	Mica Mg
69.19	G-2	17.7	376	11.11	W-1	?	MRG-1
67.31	GSP-1	17.56	DR-N	9.95	NIM-L	13.35	BR
67.1	70a	17.22	AGV-1	9.69	DR-N	7.78	JB-1
67.1	375	17.16	NIM-S	9.68	BM	7.56	NIM-N
67.1	376	16.57	T-1	9.6?	Mica Mg	7.46	BM
65.2	99a	16.47	NIM-N	9.13	JB-1	6.63	W-1
63.54	NIM-S	16.20	BM	8.95	NIM-N	4.6?	Mica Fe
62.8?	TS	16.0?	TS	8.60	DTS-1	4.47	DR-N
62.69	T-1	15.4	Mica Mg	8.45	UB-N	3.49	BCR-1
60.30	TB	15.35	G-2	8.28	PCC-1	1.94	TB
59.72	AGV-1	15.19	GSP-1	7.3?	TS	1.86	T-1
54.85	BCR-1	14.87	W-1	6.92	TB	1.8?	TS
53.41	NS-1	14.67	JB-1	6.84	AGV-1	1.55	AGV-1
52.87	DR-N	14.51	GA	5.94	T-1	0.96	GSP-1
52.72	W-1	14.22	JG-1	4.33	GSP-1	0.95	GA
52.66	NIM-L	13.68	BCR-1	4.13	NS-1	0.77	G-2
52.65	NIM-N	13.57	NIM-L	2.86	GA	0.73	JG-1
52.61	JB-1	13.50	GM	2.67	G-2	0.63	NS-1
51.18	NIM-P	12.51	GH	2.21	JG-1	0.48	NIM-S
49.60	BM	12.13	NIM-G	2.02	GM	0.38	GM
42.15	PCC-1	10.25	BR	1.96	NIM-G	0.23	NIM-L
40.68	DTS-1	?	MRG-1	1.44	NIM-S	0.16?	FK
39.93	UB-N	6.2?	FK	1.33	GH	0.05	375
?	MRG-1	4.27	NIM-P	0.26?	FK	0.05?	NIM-G
38.97	NIM-D	2.97	UB-N	0.12	375	0.03	GH
38.39	BR	0.73	PCC-1	0.10	376	0.03	376
38.3?	Mica Mg	0.29	DTS-1	0.08	70a	0.02	99a
34.4	Mica Fe	0.26	NIM-D	0.06	99a		

*Per cent, dry basis. See "Precautionary Notes ...", p. 6. (cont'd...)

TABLE 2 (continued)

"Usable" Values - Arranged by Major and Minor Components*

CaO		Na_2O		K_2O		TiO_2	
?	MRG-1	10.4	375	15.40	NIM-S	?	MRG-1
13.87	BR	9.86	NS-1	11.8	70a	2.61	BR
11.47	NIM-N	8.35	NIM-L	11.2	376	2.55?	Mica Fe
10.98	W-1	6.2	99a	10.0?	Mica Mg	2.22	BCR-1
9.30	JB-1	4.64	BM	8.8?	Mica Fe	1.67?	Mica Mg
7.09	DR-N	4.40	T-1	6.51	NS-1	1.35	JB-1
6.98	BCR-1	4.31	AGV-1	5.52	NIM-L	1.14	BM
6.44	BM	4.06	G-2	5.50	GSP-1	1.10	DR-N
5.11	T-1	3.85	GH	5.2	99a	1.07	W-1
5.00	AGV-1	3.76	GM	5.04	NIM-G	1.06	NS-1
3.19	NIM-L	3.55	GA	4.9?	TS	1.05	AGV-1
2.67	NIM-P	3.39	JG-1	4.76	GH	0.93	TB
2.45	GA	3.36	NIM-G	4.74	GM	0.73?	TS
2.18	JG-1	3.29	BCR-1	4.50	G-2	0.66	GSP-1
2.14	99a	3.07	BR	4.2?	FK	0.59	T-1
2.02	GSP-1	3.00	DR-N	4.03	GA	0.50	G-2
1.98	G-2	2.83	376	3.96	JG-1	0.49	NIM-L
1.72	NS-1	2.82	JB-1	3.85	TB	0.38	GA
1.18	UB-N	2.80	GSP-1	2.93	AGV-1	0.38	375
1.02	GM	2.55	70a	1.73	DR-N	0.26	JG-1
0.89	375	2.47	NIM-N	1.68	BCR-1	0.21	GM
0.77	NIM-G	2.15	W-1	1.43	JB-1	0.20	NIM-P
0.69	GH	1.31	TB	1.41	BR	0.20	NIM-N
0.68	NIM-S	?	MRG-1	1.24	T-1	0.12	UB-N
0.54	376	0.41	NIM-S	0.78	375	0.09	NIM-G
0.53	PCC-1	0.38	NIM-P	0.64	W-1	0.08	GH
0.45?	Mica Fe	0.30?	Mica Fe	0.25	NIM-N	0.06?	FK
0.30	TB	0.25?	FK	0.20	BM	0.05	NIM-S
0.26	NIM-D	0.10?	Mica Mg	?	MRG-1	0.02	NIM-D
0.18?	TS	0.10?	TS	0.09	NIM-P	0.01	DTS-1
0.15	DTS-1	0.10?	UB-N	0.02	NIM-D	0.01	PCC-1
0.12?	FK	0.06?	NIM-D	0.02?	UB-N	0.01	70a
0.11	70a	0.01	DTS-1			0.01	99a
0.10?	Mica Mg	0.01	PCC-1			0.01	376

*Per cent, dry basis. See "Precautionary Notes ...", p. 6. (cont'd...)

TABLE 2 (continued)

"Usable" Values - Arranged by Major and Minor Components*

MnO		BaO		SrO		Cr_2O_3	
0.76	NIM-L	0.27	NIM-S	0.54	NIM-L	3.62	NIM-P
0.35?	Mica Fe	0.26	99a	0.16	BR	0.64	DTS-1
0.26?	Mica Mg	0.21	G-2	0.15?	NS-1	0.44	PCC-1
0.22	NIM-P	0.15	GSP-1	0.08	AGV-1	0.41	NIM-D
0.21	NIM-D	0.14	AGV-1	0.06	G-2	0.32	UB-N
0.21	DR-N	0.13?	NS-1	0.05	DR-N	0.06	BR
0.20	BR	0.11	BR	0.05	JB-1	0.02	BM
0.19	NS-1	0.10	GA	0.05?	T-1	0.02	W-1
0.19	BCR-1	0.08	BCR-1	0.04	BCR-1	0.01	NIM-N
0.18	NIM-N	0.08	TB	0.04	GA	0.01	TB
0.17	W-1	0.07?	T-1	0.03	GSP-1		
?	MRG-1	?	JG-1	0.03	NIM-N		
0.16	JB-1	0.05	NIM-L	0.03	BM	NiO	
0.14	BM	0.04	GM	0.02	GM		
0.12	PCC-1	0.04	DR-N	0.02	TB	0.32	PCC-1
0.12	UB-N	0.03	BM	0.02	JG-1	0.31	DTS-1
0.11	DTS-1	0.02	W-1	0.02	W-1	0.29	NIM-D
0.11	T-1	0.02	70a	0.01	NIM-S	0.25	UB-N
0.10	AGV-1	0.02	NIM-G			0.07	NIM-P
0.09	GA	0.01	NIM-N			0.03	BR
0.06	JG-1	0.01	NIM-P			0.02	NIM-N
0.05	GH					0.01	W-1
0.05	TB					0.01	BM
0.04	G-2					0.01	TB
0.04	GSP-1						
0.04	GM						
0.04?	TS						
0.02	NIM-G						
0.01	NIM-S						
0.01?	FK						

*Per cent, dry basis. See "Precautionary Notes ...", p. 6. (cont'd...)

TABLE 2 (continued)

"Usable" Values - Arranged by Major and Minor Components*

ZrO_2		Nb_2O_5		FeO		Fe_2O_3	
1.63	NIM-L	0.12?	NIM-L	19.2?	Mica Fe	?	MRG-1
0.09	NS-1	0.02	NS-1	14.67	NIM-D	8.76	
0.07	GSP-1	0.01?	BR	10.47	NIM-P	6.5?	TS
0.04	G-2	0.01?	GH	9.05	BCR-1	5.61	BR
0.04	NIM-G			8.73	W-1	5.46	UB-N
0.03	AGV-1			?	MRG-1	4.57	AGV-1
0.03	BR			7.49	NIM-N	4.4?	Mica Fe
0.02	BCR-1			7.28	BM	3.78	DR-N
0.02	DR-N			6.98	DTS-1	3.48	BCR-1
0.02	GA			6.8?	Mica Mg	2.80	T-1
0.02	GH			6.60	BR	2.50	PCC-1
0.02	GM			6.12	JB-1	2.38	NS-1
0.02	T-1	RE_2O_3T		5.43	TB	2.32	JB-1
0.02	TB			5.32	DR-N	2.0?	Mica Mg
0.01	GM			5.17	PCC-1	1.77	GSP-1
0.01	W-1	0.10?	GSP-1	2.91	T-1	1.60	BM
		0.06?	NS-1	2.69	UB-N	1.40	W-1
		0.05?	NIM-L	2.31	GSP-1	1.36	GA
		0.04?	G-2	2.08	AGV-1	1.12	NIM-P
		0.04?	NIM-G	1.66	JG-1	1.08	NIM-S
		0.03?	TB	1.58	NS-1	1.01	G-2
		0.02?	AGV-1	1.45	G-2	0.91	TB
		0.02?	BCR-1	1.32	GA	0.85	DTS-1
		0.02?	GM	1.30	NIM-G	0.75	GM
		0.01?	BM	1.14	GM	0.70	NIM-D
		0.01?	BR	1.04	NIM-L	0.63	NIM-G
		0.01?	GA	0.84	GH	0.62	NIM-N
		0.01?	GH	0.72?	TS	0.41	GH
		0.01?	W-1	0.29	NIM-S	0.36	JG-1

*Per cent, dry basis. See "Precautionary Notes ...", p. 6. (cont'd...)

TABLE 2 (continued)

"Usable" Values - Arranged by Major and Minor Components*

H_2O+		CO_2		P_2O_5	
11.28	UB-N	1.34?	BM	1.05	BR
4.64	PCC-1	?	MRG-1	0.49	AGV-1
4.1?	TS	0.86	BR	0.45?	Mica Fe
3.82	TB	0.44?	UB-N	0.33	BCR-1
3.62	BM	0.42?	NIM-D	0.28	GSP-1
2.8?	Mica Fe	0.28?	GM	0.28	NS-1
2.44	NIM-L	0.21?	NIM-L	0.28?	TS
2.31	BR	0.20?	Mica Fe	0.26	JB-1
2.20	DR-N	0.20?	Mica Mg	0.25	DR-N
1.70?	Mica Mg	0.19?	JB-1	0.14	G-2
1.51	T-1	0.16	PCC-1	0.14	NIM-S
?	MRG-1	0.15?	DR-N	0.14	T-1
1.01	JB-1	0.14	GH	0.14	W-1
0.87	GA	0.14	NS-1	0.12	GA
0.82	AGV-1	0.13	TB	0.10	GM
0.73	BCR-1	0.12	GSP-1	0.10	JG-1
0.65	NS-1	0.11	GA	0.10	TB
0.57	GSP-1	0.10?	NIM-N	0.08?	FK
0.55	G-2	0.10?	NIM-S	0.07	NIM-L
0.53	W-1	0.09?	JG-1	0.06	GM
0.53	JG-1	0.08	G-2	0.04	NIM-N
0.46	GH	0.08?	NIM-G	0.03	NIM-D
0.46	DTS-1	0.08?	NIM-P	0.03?	Mica Mg
0.42	NIM-G	0.08?	T-1	0.03	UB-N
0.41?	FK	0.06	DTS-1	0.02	NIM-G
0.35	GM	0.06	W-1	0.02	NIM-P
0.31	NIM-N	0.04?	TS	0.01	GH
0.26	NIM-D	0.03?	BCR-1		
0.25	NIM-P	0.02?	FK		
0.23	NIM-S	0.01	AGV-1		

*Per cent, dry basis. See "Precautionary Notes ...", p. 6. (cont'd...)

TABLE 2 (continued)

"Usable" Values - Arranged by Major and Minor Components*

Cl		F		S	
0.11?	NIM-L	2.7?	Mica Mg	0.06	NIM-L
0.06?	NIM-G	1.6?	Mica Fe	?	MRG-1
0.04	BR	0.43?	NIM-G	0.04	BCR-1
0.04	GSP-1	0.43?	NIM-L	0.04	GSP-1
0.04?	NIM-D	0.38	GSP-1	0.04?	BR
0.02	W-1	0.30	GH	0.02	NS-1
0.02	AGV-1	0.14	NS-1	0.02?	TS
0.02?	NIM-S	0.13	G-2	0.01	AGV-1
0.01	G-2	0.10	BR	0.01	PCC-1
0.01	GH	0.07?	GM	0.01?	NIM-G
0.01	PCC-1	0.07?	TB	0.01?	NIM-N
0.01	BCR-1	?	JG-1	0.01?	NIM-P
0.01?	NIM-P	?	T-1	0.01?	NIM-S
0.01?	NIM-N	0.05	BCR-1	?	T-1
		0.05	GA		
		0.04	AGV-1		
		0.04?	NIM-N		
		0.03?	BM		
		0.02	W-1		
		0.02?	NIM-P		
		0.02?	NIM-S		

*Per cent, dry basis. See "Precautionary Notes ...", p. 6.

TABLE 3

"Usable" Values - Arranged by Trace Elements*

Ag		Ba		Bi		Co		
0.11	AGV-1	2400	NIM-S	1000 ?	VS-N	700		VS-N
.081	W-1	1850	G-2	0.057	AGV-1	200		NIM-D
.03?	BCR-1	1300	GSP-1	0.050	BCR-1	135		DTS-1
.008	DTS-1	1200	AGV-1	.046?	W-1	115		NIM-P
.005	PCC-1	1150?	NS-1	.043	G-2	110		PCC-1
		1050	BR	.037?	GSP-1	110		UB-N
		900	VS-N	.013	PCC-1	61		NIM-N
As		850	GA	.010	DTS-1	50		BR
		720	TB			50		W-1
1.9	W-1	680	BCR-1			39	?	JB-1
0.05?	DTS-1	660?	T-1	Cd		37		BCR-1
		450	NIM-L			35		DR-N
		380	DR-N	900 ?	VS-N	34		BM
Au (ppb)		330	GM	0.15	W-1	18	?	Mica Fe
		260	BM	.039	G-2	17		AGV-1
8. ?	NIM-G	210	NIM-G			13		TB
5. ?	W-1	160	W-1			13	?	T-1
4. ?	NIM-L	110	NIM-N	Ce		7		GSP-1
1.6?	GSP-1	48	NIM-P			7	?	NS-1
1.0?	G-2	40?	UB-N	900?	VS-N	6		G-2
		22	GH	390?	GSP-1	6	?	JG-1
		20?	NIM-D	330?	NIM-P	5		GA
B				280?	NIM-L	5	?	NIM-G
				200?	NIM-G	3.5		GM
300?	VS-N	Be		150?	G-2	3.		NIM-L
92?	TB			115?	TB	3.		NIM-S
26?	GA	6. ?	GH	63?	AGV-1	2.		GH
15?	W-1	6. ?	NS-1	60?	GM			
13?	GM	4.4?	GM	54	BCR-1			
		4. ?	GA	23?	BM			
		4. ?	TB	23?	W-1			
		2.6	G-2	15?	NIM-N			
		1.5?	GSP-1	12?	NIM-S			
		1.3?	BM					
		1.	BR					
		0.8	W-1					

*Parts per million (except where shown)
See "Precautionary Notes ...", p. 6.

(cont'd...)

TABLE 3 (continued)

"Usable" Values - Arranged by Trace Elements*

Cr		Cs		Cu		Dy	
700	VS-N	900 ?	VS-N	800	VS-N	15. ?	NIM-G
420	BR	7.6	GM	110	W-1	6.3	BCR-1
420?	JB-1	6.8	TB	70	BR	5.4	GSP-1
125	BM	6. ?	NIM-S	63	AGV-1	4.	W-1
120	W-1	5. ?	GA	52	DR-N	3.5	AGV-1
90?	Mica Fe	3.5 ?	NS-1	50	TB	2.6	G-2
80	TB	3. ?	NIM-L	47?	T-1	0.003	DTS-1
50?	JG-1	2. ?	NIM-G	45	BM		
45	DR-N	1.7 ?	BM	35	GSP-1		
34	NIM-N	1.3	G-2	30	UB-N	Er	
24?	T-1	1.3	AGV-1	19	NIM-S		
16	BCR-1	1.0	GSP-1	19	BCR-1	3.6	BCR-1
15	NIM-G	0.95	BCR-1	15	NIM-L	2.4	W-1
15	NIM-L	.9	W-1	14	GA		
13	GSP-1	.006	DTS-1	14	NIM-P		
12	AGV-1	.006	PCC-1	13	GM	Eu	
12	NIM-S			13	NIM-G		
11?	NS-1			13	NIM-N	2.4?	GSP-1
10	GM			12	GH	2. ?	NIM-L
10	GA			11	G-2	2. ?	NIM-G
9	G-2			11	PCC-1	1.9	BCR-1
6	GH			10?	NS-1	1.7?	AGV-1
				10?	NIM-D	1.5	G-2
				7	DTS-1	1.1	W-1
				7?	JG-1	0.5	NIM-N
				4?	Mica Fe	0.5	NIM-S

*Parts per million (except where shown)
See "Precautionary Notes ...", p. 6.

(cont'd...)

TABLE 3 (continued)

"Usable" Values - Arranged by Trace Elements*

Ga		Ge		Ho		Li	
400?	VS-N	2.5 ?	TB	1. ?	W-1	1500?	Mica Fe
90?	Mica Fe	1.7 ?	W-1	0.003?	DTS-1	500?	VS-N
60?	NIM-L	1.6 ?	GM			115	TB
33?	NS-1	1.5 ?	BCR-1			100?	GA
30?	NIM-G	1.5 ?	GA	In		70	BM
25	TB	1.15	G-2			51	GM
25	DR-N	0.93	PCC-1	0.095?	BCR-1	45	DR-N
23	BCR-1	0.90?	DTS-1	.065	W-1	42	GH
23	G-2			.034?	G-2	37	G-2
22	GH			.0025?	DTS-1	34	GSP-1
21	GSP-1	Hf				30?	UB-N
21?	T-1			Ir (ppb)		20	NS-1
20	AGV-1	300 ?	NIM-L			14	AGV-1
20?	BR	13 ?	GSP-1			13	BCR-1
20?	NIM-N	10 ?	NIM-G	5.2?	PCC-1	12	W-1
16	GA	7.5?	G-2	0.28?	W-1	12?	BR
16	W-1	5. ?	AGV-1				
16	GM	4.5	BCR-1				
15	BM	2. ?	W-1	La		Lu	
10?	NIM-S						
7?	UB-N			800?	VS-N	3. ?	NIM-G
		Hg (ppb)		200	GSP-1	1. ?	NIM-L
				200?	NIM-L	0.55 ?	BCR-1
Gd		39?	G-2	100	G-2	.4 ?	BM
		16?	GSP-1	100?	NIM-G	.35 ?	W-1
6.6	BCR-1	15?	AGV-1	85?	BR	.28 ?	AGV-1
4. ?	W-1	14?	JB-1	70?	NIM-S	.23 ?	GSP-1
		11?	BCR-1	56?	TB	.2 ?	NIM-N
		9?	DTS-1	45?	AGV-1	.11 ?	G-2
		7?	PCC-1	36?	GA	.006?	PCC-1
		7?	JG-1	35?	GM		
				25	BCR-1		
				25?	GH		
				12?	W-1		
				9?	BM		
				3?	NIM-N		
				3?	NIM-P		

*Parts per million (except where shown)
See "Precautionary Notes ...", p. 6.

(cont'd...)

TABLE 3 (continued)

"Usable" Values - Arranged by Trace Elements*

Mo			Nd		Os (ppb)		Ra (ppb)		
700	?	VS-N	190?	GSP-1	0.25?	W-1	1.25	?	JG-1
4	?	GH	70?	NIM-L			0.72	?	JB-1
3	?	AGV-1	60?	G-2			.71	?	G-2
3	?	BCR-1	50?	NIM-G	Pb		.69	?	AGV-1
2	?	BR	39?	AGV-1			.66	?	GSP-1
1.1	?	GM	29	BCR-1	1000	VS-N	.56	?	BCR-1
1.	?	G-2	15	W-1	70	DR-N	.0018	?	PCC-1
1.	?	GSP-1			53	GSP-1	.0003	?	DTS-1
0.6	?	BM			50	GH			
0.6	?	W-1	Ni		45?	NIM-L			
					37?	T-1	Rb		
			800	VS-N	36	AGV-1			
N			570	NIM-P	35?	NIM-G	2300	?	Mica Fe
			270	BR	30	GM	800	?	VS-N
56?		G-2	120	NIM-N	29	G-2	560		NIM-S
52?		W-1	78	W-1	26	GA	390		GH
48?		GSP-1	57	BM	24?	JG-1	340		NIM-G
44?		AGV-1	40	TB	20?	UB-N	250		GSP-1
43?		PCC-1	40?	Mica Fe	17?	Mica Fe	250		GM
30?		BCR-1	22	DR-N	16?	BR	215		NS-1
27?		DTS-1	17	AGV-1	15	BCR-1	200		NIM-L
			13	BCR-1	12	BM	185		JG-1
			13?	T-1	11	DTS-1	180		TB
Nb			10?	NIM-G	10	PCC-1	175		GA
			10?	NIM-L	8	W-1	170		G-2
850	?	NIM-L	9	GSP-1	7	TB	75		DR-N
700		VS-N	8?	NIM-S			67		AGV-1
165		NS-1	7.5	GM			47		BCR-1
90	?	BR	7.	GA	Pd (ppb)		45		BR
85	?	GM	7.?	NS-1			40		JG-1
29		GSP-1	6	G-2	25?	W-1	33	?	T-1
15		AGV-1	3	GH			21		W-1
14		BCR-1					12		BM
14		G-2			Pr		0.06	?	PCC-1
13	?	GA					.05	?	DTS-1
9.5	?	W-1			4	W-1			

*Parts per million (except where shown)
See "Precautionary Notes ...", p. 6.

(cont'd...)

TABLE 3 (continued)

"Usable" Values - Arranged by Trace Elements*

Re (ppb)		Sc		Sm		Sr	
0.8 ?	BCR-1	300 ?	VS-N	27 ?	GSP-1	1350	BR
0.07?	PCC-1	40 ?	NIM-N	9 ?	TB	1300?	NS-1
		35 ?	W-1	7.3?	G-2	700	VS-N
Rh (ppb)		34	BCR-1	6.6?	BCR-1	660	AGV-1
		34	BM	6. ?	GM	480	G-2
1.0?	PCC-1	30 ?	NIM-P	5.9?	AGV-1	440	JB-1
0.9?	DTS-1	26 ?	BR	4.8?	JB-1	400	DR-N
0.2?	BCR-1	13.5	TB	4.6?	JG-1	390	T-1
		12	AGV-1	4. ?	BM	330	BCR-1
Ru (ppb)		9	PCC-1	3.6?	W-1	300	GA
		8	GSP-1			270	NIM-N
9.5?	PCC-1	7 ?	GA			230	GSP-1
		5.1	GM	Sn		230	BM
		5. ?	NIM-D			190	W-1
		4.	G-2	800 ?	VS-N	185	JG-1
		4. ?	DTS-1	65 ?	Mica Fe	150	TB
Sb		4. ?	NIM-S	10 ?	GH	135	GM
		0.5?	NIM-G	8 ?	BR	76	NIM-S
800 ?	VS-N	0.5?	NIM-L	6 ?	GSP-1	32	NIM-P
4.3?	AGV-1			6 ?	NS-1	12	NIM-G
3.3?	TB			5.7	TB	10	GH
3.1?	GSP-1			4.6	GM	10?	UB-N
2.0?	BM			4. ?	AGV-1	0.4	PCC-1
1.4	PCC-1			4. ?	BCR-1	0.35	DTS-1
1.0	W-1			4. ?	GA		
1.0?	NIM-P			3.2	W-1		
0.6	BCR-1			3. ?	DTS-1		
0.6?	DTS-1			2. ?	PCC-1		
0.5?	GM			1.9?	G-2		
0.5?	NIM-D			1.7	BM		
0.5?	NIM-G						
0.5?	NIM-L						
0.5?	NIM-S						
0.1?	G-2						

*Parts per million (except where shown)
See "Precautionary Notes ...", p. 6.

(cont'd...)

TABLE 3 (continued)

"Usable" Values - Arranged by Trace Elements*

Ta		Th		U		V	
900 ?	VS-N	105	GSP-1	14.	NIM-G	600?	VS-N
20 ?	NIM-L	70	NIM-L	12.	NIM-L	410	BCR-1
10 ?	NS-1	57	NIM-G	3.3?	JG-1	250	NIM-P
4 ?	NIM-G	35 ?	GM	2.0	AGV-1	240	BR
1.0	GSP-1	24	G-2	2.0	G-2	240	W-1
0.9	AGV-1	19 ?	TB	2.0	GSP-1	220	DR-N
0.9	BCR-1	15 ?	GA	1.8	BCR-1	220	NIM-N
0.9	G-2	13 ?	JG-1	1.8	JB-1	180	BM
0.5	W-1	6.4	AGV 1	0.5	W-1	125	AGV-1
		6.0	BCR-1	.5?	NIM-D	105	TB
		3. ?	BM	.5?	NIM-N	96?	T-1
Tb		2.4	W-1	.5?	NIM-P	79	NIM-L
				.005?	DTS-1	75	UB-N
3. ?	NIM-G			.005?	PCC-1	60	NS-1
1.3	GSP-1	Tl				49	GSP-1
1.0	BCR-1					42	NIM-D
1.0?	NIM-L	0.3 ?	BCR-1			36	GA
0.70	AGV-1	0.11?	W-1			34	G-2
0.65	W-1					31	PCC-1
0.54	G-2					13	DTS-1
		Tm				11	GM
						9	NIM-S
		0.6	BCR-1			5?	GH
		0.3	W-1				

*Parts per million (except where shown)
See "Precautionary Notes ...", p. 6.

(cont'd...)

TABLE 3 (continued)

"Usable" Values - Arranged by Trace Elements*

W		Yb		Zn		Zr	
3 ?	TB	900 ?	VS-N	1350?	Mica Fe	700?	VS-N
2 ?	GM	10 ?	NIM-G	800	VS-N	650	NS-1
1 ?	BM	8 ?	GH	280?	NIM-L	500	GSP-1
0.5?	W-1	4 ?	BR	220?	T-1	300	G-2
		4 ?	TB	160	BR	260	NIM-G
Y		4 ?	NIM-L	150	DR-N	240	BR
		3.8	BCR-1	120	BCR-1	220	AGV-1
800?	VS-N	3.5?	BM	115	BM	185	BCR-1
70?	GH	3. ?	GM	100?	NIM-P	180	TB
46	BCR-1	2.5	GSP-1	98	GSP-1	170?	T-1
39?	TB	2.5?	GA	95	TB	160	GH
32	GSP-1	2.1	W-1	90?	NIM-D	145	GM
27?	BR	2.0	AGV-1	86	W-1	140	GA
26	AGV-1	0.9	G-2	85	G-2	125	DR-N
26?	BM			85	NIM-N	105	W-1
26?	GM			85?	UB-N	96	BM
25	W-1			84	AGV-1		
18?	GA			83?	JB-1		
12	G-2			80	GH		
				75	GA		
				60?	NIM-G		
				45	DTS-1		
				40	GM		
				36	PCC-1		
				36?	JG-1		
				20?	NIM-S		

*Parts per million (except where shown)
See "Precautionary Notes ...", p. 6.