UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

**Computerized spectrographic data for two new
USGS rocks, AMH-1 and DTS-2**

By

Carol J. Skeen^{*} and William B. Crandell^{*}

Open-File Report 89-183

^{*}U.S. Geological Survey, MS 923, 12202 Sunrise Valley Drive, Reston, VA

CONTENTS

	Page
Abstract.....	1
Introduction.....	1
Analytical Technique.....	2
Results and Discussion.....	4
Conclusions.....	6
References Cited.....	6

TABLES

Table 1. Computerized spectrographic data for andesite, AMH-1.....	8
Table 2. Computerized spectrographic data for dunite, DTS-2.....	10
Table 3. Computerized spectrographic data for USGS standards, AGV-1 and DTS-1.....	12
Table 4. Computerized spectrographic data for AGV-2 and AGV-1.....	14

ABSTRACT

Major and trace element contents of andesite, AMH-1, and dunite, DTS-2, were determined by computerized semiquantitative spectrographic analysis. Analysis of variance shows no significant difference for between bottle and within bottle variances at the 95% confidence level so the two rock samples may be accepted as homogeneous for all elements determined by this method. Estimates of the averages and of the standard deviations for bottles and for error are included in the tables along with the data obtained with the computer. A single preliminary analysis of AGV-2, in preparation as a replacement for AGV-1, is also reported. Established USGS rock standards, AGV-1 and DTS-1, were used as quality control samples for the characterization of AMH-1 and DTS-2.

INTRODUCTION

Supplies of USGS standards for geochemical investigations are being continually exhausted. Thus, the search for replacement standards is an ongoing concern. The sources of the rocks from which the andesite, AMH-1, and the dunite, DTS-2, were prepared are given below.

Andesite, AMH-1, was collected from a volcanic flow exposed at a parking lot at Timberline Lodge, south side of Mt. Hood at Long 121° 42' 30" W, Lat 45° 19' 19" N. This is a pyroxene andesite. Andesite, AGV-1, was also from Oregon but was collected about 250 miles SSE of AMH-1.

Andesite, AGV-2, was collected from the same site as AGV-1.

Dunite, DTS-2, was collected in the Twin Sisters location in Oregon, Long 121° 58' W, Lat 48° 45'. This is the same location from where DTS-1 was collected.

ANALYTICAL TECHNIQUE

The processing of these samples followed the procedure previously described (Flanagan, 1967). An important part of the procedure consisted of randomly selecting three bottles, one from each third of the total batch of prepared sample. Two portions from each of the three bottles for each different rock sample were randomly analyzed. The analytical data were then re-ordered to evaluate the analysis of variance. AGV-1 and DTS-1 were analyzed at the same time to allow direct comparison of elements in a standard USGS andesite and a standard USGS dunite. AGV-2 was analyzed in a separate sample sequence.

The computerized analysis of spectrographic data from photographed optical emission spectra is routine. The basic recorder system (Helz et al., 1969) and computer program (Walthall, 1974) have been described, but a 4-by-20-in photographic plate is now used in place of the two 4-by-10-in plates. Refinement of the computer program by Catharine P. Thomas (1975) resolved problems of spectral-line interferences.

Duplicate 15-mg portions from each of the three randomly selected bottles of each of the rocks were mixed with 30 mg of graphite. After the electrodes were loaded, the 12 samples were arced and analyzed in random order. The samples were arced in a 70% argon-30% oxygen atmosphere under carefully controlled conditions as described by Dorrzapf (1973). After the plates were developed (Dorrzapf, 1973) the spectra were recorded and analyzed as previously described (Helz and others, 1969).

The basis of the system is a scanning microphotometer. The optical system follows conventional practices for good resolution, high contrast, and low scattered or diffused light detection. The optics are designed to sample a portion of the spectrum 1 mm high by 7 μ m wide (about a quarter of the width

of a spectral line). Light passing through the plate is detected by a solid state detector and then is sampled by an analog-to-digital (A/D) converter.

The heart of the signal processing system is a 2100S Hewlett-Packard* (H-P) minicomputer with 32K of memory. Within 5 minutes after recording the last sample, the requested number of two-page report forms containing the concentrations of 64 elements for as many as 10 samples on each report form are printed on the H-P 2607A line printer. Information about effective arc temperature and electron pressure during each arcing and the calculated total oxides (considering only major constituents) for each sample also are available (Golightly et al., 1977).

The computer algorithm calculates the coefficients of first and second degree polynomials for the analytical curve of $\ln$ intensity vs. $\ln$ concentration. It evaluates the curve for range, goodness of fit, and slope. It suggests a working concentration range for the line such that a lower limit defined by a signal/noise ratio of 2 is maintained (Walthall, 1974).

Each photoplate contains spectra from several standard reference materials in addition to spectra from a suite of samples and an iron two-step calibration spectrum. The standard reference materials are selected from 20 well-characterized rocks chosen to represent the variety of materials analyzed. The analyst selects rock standards that are compositionally similar to the samples described by the individual requesting the analyses. The computer program recognizes these rock standards and compares the results calculated for Si, Al, Fe, Ca, Mg, Ti, Co, Pb, and Zr with accepted values in

*Any use of tradenames or trademarks is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

these standards. These nine elements were chosen because they include major rock constituents and have a wide range in volatility, thus enabling checks for loss of refractory elements if a molten bead pops from the anode during the arcing procedure.

The analyst makes an evaluation of the analytical usefulness of the line on the basis of its profile, intensity, and location. The data can be automatically entered into the wavelength table.

On the basis of the tabulated data from standard reference materials interferences can be identified so that line priorities and concentration ranges can be adjusted to circumvent errors.

Generalized interference treatments are of two types: subtraction or line changing. The subtraction routine allows gross corrections by subtracting an equivalent concentration contributed by the interfering line. This subtraction uses prestored coefficients, relating the concentration of interference to apparent concentration of analyte, all of which have been predetermined in the absence of the analyte.

The matrix of DTS-2 has created an unresolved interference for Li and neither can V and Zn values be determined because of the high concentrations of Cr and Ni. The symbol "H" is reported in cases of unresolved interferences.

RESULTS AND DISCUSSION

Analyses of elements by this method are presently not as accurate as analyses by wet chemical or X-ray fluorescence methods, but the method represents a significant improvement over visual determinations. The data obtained are semiquantitative for several reasons. Standards used are similar to synthetic standards of Myers and others (1961) that were made to approximate the "average" silicate rock. Six-step concentrations of these

standards are arced on separate plates. Prestored coefficients of the analytical curves obtained from the arcing of these standards are used to compute the concentrations of samples arced and recorded later (Thomas, 1979; Walthall, 1974). Since arcing conditions are not exactly reproducible between plates, well-characterized USGS standard rocks are analyzed on the same plate as the samples. For quantitative data, standards need to be arced on each plate and calibration coefficients based on those standards are determined for each plate individually.

Tables 1 and 2 contain data for elements in AMH-1 and DTS-2. For AMH-1, 35 elements were at concentrations below the detection limit for that element, which is reported as a "less than" in the table. There were 43 elements with concentrations below the detection limit in DTS-2.

Computations for the analysis of variance were performed for the data, except where one or more observations were missing or where reported as less than a lower limit. The estimates of the mean and the standard deviation for bottles and for errors and the conclusions regarding homogeneity from the F tests resulting from the calculations are included in the tables.

Tables 3 and 4 provide semiquantitative data for USGS standards AGV-1 and DTS-1 and for AGV-2, which is also being prepared for use as a pyroxene andesite standard. The data for AGV-1 and DTS-1 are well within the recommended values for these rocks.

DTS-2 appears to be very similar to DTS-1. Chromium is the only element of a significantly different concentration. It was found to be greater by a factor of 3 in DTS-2 than in DTS-1.

AMH-1 appears to be more similar to AGV-1 than AGV-2 might be. Only elements barium, chromium, lead, and zirconium are greater in AGV-1 by a factor of 3 than in AMH-1. However, sodium, titanium, niobium, silver,

lanthanum, yttrium, ytterbium, lead, and zirconium appear to be significantly different between AGV-1 and AGV-2. With continued study of AGV-2, these differences will become more conclusive.

CONCLUSIONS

Negative values for the estimates of within bottle variances may be attributed to sample fluctuations about an average of zero. However, negative values preclude calculation of an F ratio. When the variation due to bottles randomly selected from the three thirds is not significant, the sample is declared to be homogeneous for that element. AMH-1 and DTS-2 are homogeneous for all elements where F ratio could be calculated. DTS-2 appears to be very similar to DTS-1 and promises to be a good replacement for it. It appears AMH-1 would be a better choice than AGV-2 for replacement of AVG-1.

REFERENCES CITED

- Dorrzapf, A.F., Jr., 1973, Spectrochemical Computer Analysis - Argon - Oxygen d-c Arc Method for Silicate Rocks: U.S. Geological Survey Journal of Research, v. 1, No. 5, p. 559-562.
- Flanagan, F.J., 1967, U.S. Geological Survey Silicate Rock Standards: Geochimica et Cosmochimica Acta, v. 31, p. 289-308.
- Golightly, D.W., Dorrzapf, A.F., Jr., and Thomas, C.P., 1977, Sets of Spectral Lines for Spectrographic Thermometry and Manometry in D.C. Arcs of Geologic Materials: Spectrochimica Acta, v. 32B, p. 313-325.
- Helz, A.W., Walthall, F.G., and Berman, Sol, 1969, Computer Analysis of Photographed Optical Emission Spectra: Applied Spectroscopy, v. 23, p. 508-518.
- Myers, A.T., Havens, R.G., and Dunton, P.G., 1961, A Spectrochemical Method for the Semiquantitative Analysis of Rocks, Minerals, and Ores: U.S. Geological Survey Bulletin 1084-I, p. 207-229.

- Thomas, Catharine P., 1975, An Integrated-Intensity Method for Emission Spectrographic Computer Analysis: U.S. Geological Survey Journal of Research, v. 3, No. 2, p. 181-185.
- Thomas, C.P., 1979, A Minicomputer-based Emission Spectrographic Analysis System Dependent on Scanning Microphotometry: Applied Spectroscopy, 33, p. 604-612.
- Walthall, Frank G., 1974, Spectrochemical Computer Analysis--Program Description: U.S. Geological Survey Journal of Research, v. 2, No. 2, p. 61-71.

TABLE 1.--Computerized spectrographic data for andesite, AMH-1

PAGE 4-A

EMISSION SPECTROGRAPHIC ANALYSIS

REPORT JOB NO. SPEC. LAB. #	PROGRAM NO. 1804 #1804	1204202 EE-2138	FOR: FRANCIS FLANAGAN DATE: 01/20/88	AMH-1-277 X-213808 8	AMH-1-712 X-213812 12	AMH-1-712 X-213821 21	AMH-1-273 X-213817 17	AMH-1-273 X-213823 23	MEAN	STANDARD DEVIATION BOTTLES 2 D.F.	ANAL. ERROR 3 D.F.	F RATIO F. 95
FIELD #	AMH-1-277	AMH-1-712	AMH-1-712	AMH-1-273	AMH-1-273	AMH-1-273	AMH-1-273	AMH-1-273	MEAN	STANDARD DEVIATION BOTTLES 2 D.F.	ANAL. ERROR 3 D.F.	F RATIO F. 95
SAMPLE SPECTRUM	X-213805 5	X-213812 12	X-213821 21	X-213817 17	X-213823 23	X-213817 17	X-213823 23	X-213823 23	MEAN	STANDARD DEVIATION BOTTLES 2 D.F.	ANAL. ERROR 3 D.F.	F RATIO F. 95
SI %	26	26	29	27	29	29	29	29	27.5	NEG	1.7	NS
AL %	8.5	12	11	11	8.6	8.6	8.6	8.6	10.4	NEG	1.5	NS
FE %	4.0	4.0	4.4	4.3	4.2	4.2	4.2	4.2	4.12	14	.19	2.05 NS
MG %	2.4	2.6	2.6	2.6	2.4	2.4	2.4	2.4	2.52	.0408	.0913	1.40 NS
CA %	5.3	4.5	4.3	4.1	5.7	5.7	5.7	5.7	4.72	NEG	.75	NS
NA %	2.4	2.0	2.0	1.8	2.6	2.6	2.6	2.6	2.13	NEG	.37	NS
K %	1.1	0.96	1.0	0.86	1.1	1.1	1.1	1.1	.992	NEG	.12	NS
TI %	0.47	0.45	0.49	0.51	0.32	0.32	0.32	0.32	.457	NEG	.0802	NS
P %	0.11	0.091	0.098	0.068	0.068	0.068	0.068	0.068	-	-	-	-
MN %	0.087	0.089	0.096	0.094	0.088	0.088	0.088	0.088	.0905	NEG	.0039	NS
AC PPM	0.24	0.25	0.26	0.27	0.21	0.21	0.21	0.21	.247	.0126	.0173	2.06 NS
AS PPM	< 220	< 220	< 220	< 220	< 220	< 220	< 220	< 220	-	-	-	-
AU PPM	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	-	-	-	-
B PPM	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	-	-	-	-
BA PPM	280	260	260	240	270	270	240	240	258.3	NEG	17	NS
BE PPM	1.7	1.6	1.6	1.6	1.7	1.7	1.6	1.6	1.63	NEG	.0577	NS
BI PPM	< 22	< 22	< 22	< 22	< 22	< 22	< 22	< 22	-	-	-	-
CD PPM	< 22	< 22	< 22	< 22	< 22	< 22	< 22	< 22	-	-	-	-
CE PPM	< 63	< 63	< 63	< 63	< 63	< 63	< 63	< 63	-	-	-	-
CO PPM	17	17	18	17	17	17	15	15	16.8	.41	.91	1.40 NS
CR PPM	51	47	48	57	52	52	49	49	50.7	NEG	4.2	NS
CU PPM	36	87	57	44	64	64	62	62	58.3	NEG	22	NS
DY PPM	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	-	-	-	-
ER PPM	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	-	-	-	-
EU PPM	< 0.68	< 0.68	< 0.68	< 0.68	< 0.68	< 0.68	< 0.68	< 0.68	-	-	-	-
GA PPM	28	30	30	28	28	28	29	29	28.8	NEG	1.2	NS
GD PPM	< 22	< 22	< 22	< 22	< 22	< 22	< 22	< 22	-	-	-	-
GE PPM	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	-	-	-	-
HF PPM	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	-	-	-	-
HO PPM	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	-	-	-	-
IN PPM	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	-	-	-	-
IR PPM	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	-	-	-	-
LA PPM	24	20	20	22	22	22	19	19	21.2	NEG	2.2	NS
LI PPM	< 32	< 32	< 32	< 32	< 32	< 32	< 32	< 32	-	-	-	-
LU PPM	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	-	-	-	-
MN PPM	870	890	890	960	940	940	880	880	905.0	NEG	39	NS
MO PPM	4.5	4.4	3.9	4.5	4.2	4.2	3.4	3.4	4.15	.15	.41	1.28 NS
NB PPM	4.8	5.1	6.4	5.9	12	12	6.8	6.8	6.83	1.7	2.1	2.32 NS
ND PPM	< 32	< 32	< 32	< 32	< 32	< 32	< 32	< 32	-	-	-	-
NI PPM	47	48	48	53	52	52	40	40	48.0	NEG	5.3	NS

TABLE 1.--Continued

REPORT	JOB NO. 1804						PAGE 4-B
FIELD #	AMH-1-277	AMH-1-712	AMH-1-273	AMH-1-273	MEAN	STANDARD DEVIATION	F RATIO
SAMPLE	X-213805	X-213812	X-213821	X-213817		BOTTLES	F.95
SPECTRUM	5	12	21	17	23	2 D.F.	3 D.F.
OS PPM	< 10	< 10	< 10	< 10	< 10	-	-
PB PPM	8.6	9.4	8.9	10	8.0	NEG	NS
PD PPM	< 0.68	< 0.68	< 0.68	< 0.68	< 0.68	-	-
PR PPM	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	-	-
PT PPM	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	-	-
RE PPM	< 10	< 10	< 10	< 10	< 10	-	-
RH PPM	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	-	-
RU PPM	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-	-
SB PPM	< 32	< 32	< 32	< 32	< 32	-	-
SC PPM	14	14	13	13	9.8	1.6	2.49 NS
SN PPM	< 3.2	< 3.2	< 3.2	3.8	3.6	-	-
SN PPM	< 4.6	< 4.6	5.8	< 4.6	< 4.6	-	-
SR PPM	510	510	480	520	470	NEG	NS
TA PPM	< 320	< 320	< 320	< 320	< 320	-	-
TB PPM	< 32	< 32	< 32	< 32	< 32	-	-
TH PPM	< 46	< 46	< 46	< 46	< 46	-	-
TL PPM	< 10	< 10	< 10	< 10	< 10	-	-
TM PPM	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2	-	-
U PPM	< 150	< 150	< 150	< 150	< 150	-	-
V PPM	110	110	110	110	85	NEG	NS
W PPM	< 10	< 10	< 10	< 10	< 10	-	-
Y PPM	12	11	11	13	7.0	NEG	NS
YB PPM	1.7	1.8	1.7	1.8	1.78	.0816	.0913
ZH PPM	50	52	45	63	49	NEG	NS
ZR PPM	100	68	87	130	54	NEG	NS

MAJORS RECALCULATED AS OXIDES

SI02 %	60	56	62	58	62
AL2O3 %	21	23	21	21	16
FE2O3 %	5.7	5.7	6.3	6.2	6.0
MGO %	4.1	4.3	4.3	4.3	4.0
CAO %	6.2	6.3	6.0	5.7	8.0
NA2O %	2.7	2.7	2.7	2.4	3.5
K2O %	1.1	1.2	1.2	1.0	1.3
TI02 %	0.83	0.75	0.82	0.85	0.53
P2O5 %	< 0.16	0.21	0.23	< 0.16	< 0.16
MNO %	0.11	0.12	0.12	0.12	0.11

1. THE RELATIVE STANDARD DEVIATION FOR EACH REPORTED CONCENTRATION IS PLUS 50% AND MINUS 33%.

2. 'N' DENOTES THE OCCURRENCE OF AN UNRESOLVED INTERFERENCE.

TABLE 2.--Computerized spectrographic data for dunite, DTS-2

EMISSION SPECTROGRAPHIC ANALYSIS

PAGE 5-A

REPORT JOB NO. SPEC. LAB. #	1804 1804	PROGRAM NO. 1204202 PLATE NO. EE-2138	FOR: FRANCIS FLANAGAN DATE: 01/20/88	C. SKEEN (ANALYST) U. B. CRANDELL (PLATE RECORDER) A. F. DORRZAPF (PROJECT LEADER)				F RATIO F.95	
				MEAN	STANDARD DEVIATION BOTTLES 2 D.F.	ANAL. ERROR 3 D.F.			
FIELD #	DTS-2-1230	DTS-2-1290	DTS-2-937	DTS-2-937	DTS-2-1012	DTS-2-1012			
SAMPLE	X-213816	X-213819	X-213824	X-213826	X-213825	X-213827			
SPECTRUM	16	19	24	26	25	27			
SI %	15	15	15	14	14	15	14.7	NEG	NS
AL %	0.068	0.052	0.052	0.038	0.046	0.053	.0515	.0042	1.42 NS
FE %	4.2	4.5	4.4	4.2	4.7	4.5	4.42	.11	1.82 NS
MG %	25	23	21	18	19	22	21.3	1.9	3.05 NS
CA %	0.046	0.041	0.050	0.047	0.043	0.043	.0450	.0025	3.26 NS
HA %	0.052	< 0.032	< 0.0032	< 0.0032	< 0.0032	0.062	-	-	-
K %	< 0.046	< 0.046	< 0.046	< 0.046	< 0.046	< 0.046	-	-	-
TI %	0.0027	0.0022	< 0.0022	< 0.0022	< 0.0022	< 0.0068	-	-	-
P %	< 0.068	< 0.068	< 0.068	< 0.068	< 0.068	< 0.068	-	-	-
MN %	0.071	0.10	0.095	0.095	0.096	0.090	.0912	NEG	NS
AG PPM	0.26	0.25	0.24	< 0.10	< 0.10	< 0.10	-	-	-
AS PPM	< 220	< 220	< 220	< 220	< 220	< 220	-	-	-
AU PPM	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	-	-	-
B PPM	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	-	-	-
BA PPM	3.3	2.5	3.7	2.2	2.5	2.9	2.83	NEG	NS
BE PPM	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	-	-	-
BI PPM	< 22	< 22	< 22	< 22	< 22	< 22	-	-	-
CD PPM	< 22	< 22	< 22	< 22	< 22	< 22	-	-	-
CE PPM	< 63	< 63	< 63	< 63	< 63	< 63	-	-	-
CO PPM	120	120	110	100	110	110	111.7	7.1	7.00 NS
CR PPM	7700	8000	7900	7100	7500	8000	7700.	NEG	NS
CU PPM	2.4	2.1	4.1	2.1	2.8	2.4	2.63	NEG	NS
DY PPM	< 10	< 10	< 10	< 10	< 10	< 10	-	-	-
ER PPM	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	-	-	-
EU PPM	< 0.68	< 0.68	< 0.68	< 0.68	< 0.68	< 0.68	-	-	-
GA PPM	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-	-	-
GD PPM	< 22	< 22	< 22	< 22	< 22	< 22	-	-	-
GE PPM	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	-	-	-
HF PPM	< 10	< 10	< 10	< 10	< 10	< 10	-	-	-
HO PPM	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	-	-	-
IN PPM	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	-	-	-
IR PPM	< 10	< 10	< 10	< 10	< 10	< 10	-	-	-
LA PPM	< 10	< 10	< 10	< 10	< 10	< 10	-	-	-
LI PPM	H	H	H	H	H	H	-	-	-
LU PPM	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	-	-	-
MN PPM	710	1000	950	950	960	900	911.7	NEG	NS
MO PPM	5.8	4.5	5.6	5.4	5.6	5.3	5.37	NEG	NS
NB PPM	< 1.5	< 1.0	< 1.5	< 1.5	< 1.5	< 1.5	-	-	-
ND PPM	< 32	< 32	< 32	< 32	< 32	< 32	-	-	-
NI PPM	4200	3200	3000	3300	3400	3100	3367.	NEG	NS

TABLE 2. Continued

REPORT	FIELD #	DTS-2-1290	DTS-2-1290	DTS-2-937	DTS-2-1012	DTS-2-1012	MEAN	STANDARD DEVIATION	F RATIO
SAMPLE SPECTRUM	X-213816	X-213819	X-213824	X-213826	X-213825	X-213827		BOTTLES 2 D.F.	F.95
	16	19	24	26	25	27		3 D.F.	
OS PPM	< 10	< 10	< 10	< 10	< 10	< 10	-	-	-
PS PPM	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	-	-	-
PD PPM	< 0.68	< 0.68	< 0.68	< 0.68	< 0.68	< 0.68	-	-	-
PR PPM	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	-	-	-
PT PPM	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	-	-	-
RE PPM	< 10	< 10	< 10	< 10	< 10	< 10	-	-	-
RH PPM	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	-	-	-
RU PPM	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-	-	-
SB PPM	< 32	< 32	< 32	< 32	< 32	< 32	-	-	-
SC PPM	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-	-	-
SN PPM	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2	-	-	-
SR PPM	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	-	-	-
TA PPM	< 320	< 320	< 320	< 320	< 320	< 320	1.15	.0866	4.00 NS
TB PPM	< 32	< 32	< 32	< 32	< 32	< 32	-	-	-
TH PPM	< 46	< 46	< 46	< 46	< 46	< 46	-	-	-
TL PPM	< 10	< 10	< 10	< 10	< 10	< 10	-	-	-
TM PPM	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2	-	-	-
U PPM	H	H	H	H	H	H	-	-	-
V PPM	22	20	17	19	19	19	19.3	1.3	3.50 NS
W PPM	< 10	< 10	< 10	< 10	< 10	< 10	-	-	-
Y PPM	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	-	-	-
YB PPM	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15	-	-	-
ZN PPM	H	H	H	H	H	H	-	-	-
ZR PPM	1.9	2.0	1.9	1.7	2.0	1.2	1.78	HEG	NS

MAJORS RECALCULATED AS OXIDES

SI02 %	32	32	32	30	30	32
AL2O3 %	0.13	0.098	0.098	0.072	0.087	0.10
FE2O3 %	6.0	6.4	6.3	6.0	6.7	6.4
MGO %	41	38	35	30	32	37
CAO %	0.064	0.057	0.070	0.066	0.060	0.060
NA2O %	0.070	< 0.043	< 0.0043	< 0.0043	< 0.0043	0.084
K2O %	< 0.055	< 0.055	< 0.055	< 0.055	< 0.055	< 0.055
TiO2 %	< 0.0045	< 0.0037	< 0.0037	< 0.0037	< 0.0037	< 0.011
P2O5 %	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16
MNO %	0.092	0.13	0.12	0.12	0.12	0.12

1. THE RELATIVE STANDARD DEVIATION FOR EACH REPORTED CONCENTRATION IS PLUS 50% AND MINUS 33%.

2. 'H' DENOTES THE OCCURRENCE OF AN UNRESOLVED INTERFERENCE.

TABLE 3.--Computerized spectrographic data for USGS standards, AGV-1 and DTS-1

EMISSION SPECTROGRAPHIC ANALYSIS

PAGE 98-A

(ANALYST)
(PLATE RECORDER)
(PROJECT LEADER)C. SKEEN
W. B. CRANDELL
A. F. DORRZAPFFOR: STD. ROCK CHECK
DATE: 01/06/88PROGRAM NO. 1204202
PLATE NO. EE-2138REPORT
JOB NO. 2138
SPEC. LAB. #2138FIELD # AGV-1 DTS-1
SAMPLE S-138001 S-138006
SPECTRUM 3 28

SI	%	26	17
AL	%	11	0.052
FE	%	4.4	5.1
MG	%	1.2	24
CA	%	3.1	0.068
NA	%	1.9	< 0.032
K	%	1.8	< 0.046
TI	%	0.65	< 0.0068
P	%	0.20	< 0.068
MN	%	0.085	0.084
AG	PPM	0.23	< 0.10
AS	PPM	< 220	< 220
AU	PPM	< 6.8	< 6.8
B	PPM	< 6.8	< 6.8
BA	PPM	1400	< 1.5
BE	PPM	2.6	< 1.5
BI	PPM	< 22	< 22
CD	PPM	< 22	< 22
CE	PPM	< 63	< 63
CO	PPM	12	120
CR	PPM	11	2800
CU	PPM	53	4.0
DY	PPM	< 10	< 10
ER	PPM	< 4.6	< 4.6
EU	PPM	< 0.68	< 0.68
GA	PPM	25	< 1.0
GD	PPM	< 22	< 22
GE	PPM	< 4.6	< 4.6
HF	PPM	< 10	< 10
HO	PPM	< 1.5	< 1.5
IN	PPM	< 6.8	< 6.8
IR	PPM	< 10	< 10
LA	PPM	49	< 10
LI	PPM	H	< 32
LU	PPM	< 6.8	< 6.8
MN	PPM	850	840
MO	PPM	2.0	< 1.0
NB	PPM	13	< 1.0
ND	PPM	46	< 32
NI	PPM	21	2500

TABLE 3.--Continued

REPORT		AGV-1		DTS-1	
FIELD #	SAMPLE	S-138001	S-138006		
SPECTRUM	3	28			
OS PPM	< 10	< 10			
PB PPM	41	8.6			
PD PPM	< 0.68	< 0.68			
PR PPM	< 6.8	< 6.8			
PT PPM	< 1.5	< 1.5			
RE PPM	< 10	< 10			
RH PPM	< 1.5	< 1.5			
RU PPM	< 1.0	< 1.0			
SB PPM	< 32	< 32			
SC PPM	13	6.0			
SM PPM	6.1	< 3.2			
SN PPM	8.6	< 10			
SR PPM	630	< 1.0			
TA PPM	< 320	< 320			
TB PPM	< 32	< 32			
TH PPM	< 46	< 46			
TL PPM	< 10	< 10			
TM PPM	< 3.2	< 3.2			
U PPM	< 150	H			
V PPM	110	11			
W PPM	< 10	< 10			
Y PPM	19	< 1.5			
YB PPM	2.0	< 0.15			
ZN PPM	61	H			
ZR PPM	300	1.2			
MAJORS RECALCULATED AS OXIDES					
SI02 %	56	36			
AL203 %	21	0.098			
FE203 %	6.3	7.3			
NGO %	2.0	40			
CAO %	4.3	0.095			
NA2O %	2.6	< 0.043			
K2O %	2.2	< 0.055			
TI02 %	1.1	< 0.011			
P205 %	0.46	< 0.16			
MNO %	0.11	0.11			

1. THE RELATIVE STANDARD DEVIATION FOR EACH REPORTED CONCENTRATION IS PLUS 50% AND MINUS 33%.

2. 'H' DENOTES THE OCCURRENCE OF AN UNRESOLVED INTERFERENCE.

3. '*' DENOTES USE OF A SAMPLE WEIGHT LESS THAN 15 MG. REPORTED RESULTS ARE BASED ON THE ACTUAL SAMPLE WEIGHT.

TABLE 4.--Computerized spectrographic data for AGV-2 and AGV-1

EMISSION SPECTROGRAPHIC ANALYSIS				PAGE	1-A
REPORT	PROGRAM NO. 1204202	FOR: FRANCIS FLANAGAN	C. SKEEN	(ANALYST)	
JOB NO. 1806	PLATE NO. EE-2140	DATE: 01/19/88	W. B. CRANDELL	(PLATE RECORDER)	
SPEC. LAB. #1806			A. F. DORZAPF	(PROJECT LEADER)	

FIELD #	AGV-2	AGV-1
SAMPLE	X-214025	X-214026
SPECTRUM	25	26
SI %	29	31
AL %	9.4	13
FE %	4.3	4.9
MG %	1.6	1.4
CA %	5.7	4.0
NA %	7.7	1.9
K %	2.2	1.9
TI %	0.33	0.76
P %	0.25	0.31
MN %	0.095	0.098
AG PPM	0.18	0.32
AS PPM	< 220	< 220
AU PPM	< 6.8	< 6.8
B PPM	< 6.8	< 6.8
BA PPM	2100	1700
BE PPM	2.8	1.7
BI PPM	< 22	< 22
CD PPM	< 22	< 22
CE PPM	< 63	< 63
CO PPM	12	15
CR PPM	20	14
CU PPM	47	68
DY PPM	< 10	< 10
ER PPM	< 4.6	< 4.6
EU PPM	1.0	0.98
GA PPM	38	33
GD PPM	< 22	< 22
GE PPM	< 4.6	< 4.6
HF PPM	< 10	< 10
HO PPM	< 1.5	< 1.5
IN PPM	< 6.8	< 6.8
IR PPM	< 10	< 10
LA PPM	23	47
LI PPM	< 32	< 32
LU PPM	< 6.8	< 6.8
MN PPM	950	980
MO PPM	3.8	2.0
NB PPM	6.5	16
ND PPM	< 32	< 32
NI PPM	23	23

TABLE 4.--Continued

JOB NO. 1806

PAGE 1-B

REPORT	FIELD #	AGV-2	AGV-1
SAMPLE SPECTRUM	X-214025	X-214026	
	25	26	
OS PPM	< 10	< 10	
PB PPM	19	53	
PD PPM	< 0.68	< 0.68	
PR PPM	< 6.8	< 6.8	
PT PPM	< 1.5	< 1.5	
RE PPM	< 10	< 10	
RH PPM	< 1.5	< 1.5	
RU PPM	< 1.0	< 1.0	
SB PPM	< 32	< 32	
SC PPM	7.8	13	
SN PPM	< 3.2	< 3.2	
SN PPM	5.3	7.8	
SR PPM	590	660	
TA PPM	< 320	< 320	
TB PPM	< 32	< 32	
TH PPM	< 46	< 46	
TL PPM	< 10	< 10	
TM PPM	< 3.2	< 3.2	
U PPM	< 150	< 150	
V PPM	85	130	
W PPM	< 10	< 10	
Y PPM	7.0	18	
YB PPM	1.9	2.6	
ZN PPM	57	82	
ZR PPM	69	210	
MAJORS RECALCULATED AS OXIDES			
SI02 %	62	66	
AL2O3 %	18	25	
FE2O3 %	6.2	7.0	
MGO %	2.7	2.3	
CAO %	8.0	5.6	
NA2O %	10	2.6	
K2O %	2.7	2.3	
TIO2 %	0.55	1.3	
P2O5 %	0.57	0.71	
MNO %	0.12	0.13	

1. THE RELATIVE STANDARD DEVIATION FOR EACH REPORTED CONCENTRATION IS PLUS 50% AND MINUS 33%.

2. 'H' DENOTES THE OCCURRENCE OF AN UNRESOLVED INTERFERENCE.

3. '*' DENOTES USE OF A SAMPLE WEIGHT LESS THAN 15 MG. REPORTED RESULTS ARE BASED ON THE ACTUAL SAMPLE WEIGHT.