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Analytical data for gold, silver, cadmium, copper, lead, and zinc in samples of stream sediments from the Mogollon and Holt Mountain quadrangles, Catron County, New Mexico

By

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CONTENTS

ILLUSTRATION

TABLES

INTRODUCTION

The Sierrita/Mogollon corridor project is a multidisciplinary study of a transect across a portion of the southern Basin and Range province; the selected transect is 100 km wide and extends from the Sierrita Mountains southwest of Tucson, Arizona, to the Mogollon Mountains, 185 km northeast in New Mexico (figure 1). Within this corridor are several porphyry copper deposits, base- and precious-metal vein deposits, a diatomite deposit, and a zeolite deposit. On-going studies are directed at understanding the mineralization, tectonic setting, and the characteristics of favorable host rocks within the different geologic terranes of the transect. The Mogollon and Holt Mountain 1:24,000 quadrangles, in Catron County, New Mexico, are located at the northeastern corner of this transect. For geochemical studies in these quadrangles, samples of stream sediment which had been collected for previous studies in these two areas by K.C. Watts and J.C. Ratté were retrieved from storage and additional chemical analyses for precious and base metals were completed using methods not available during earlier studies.

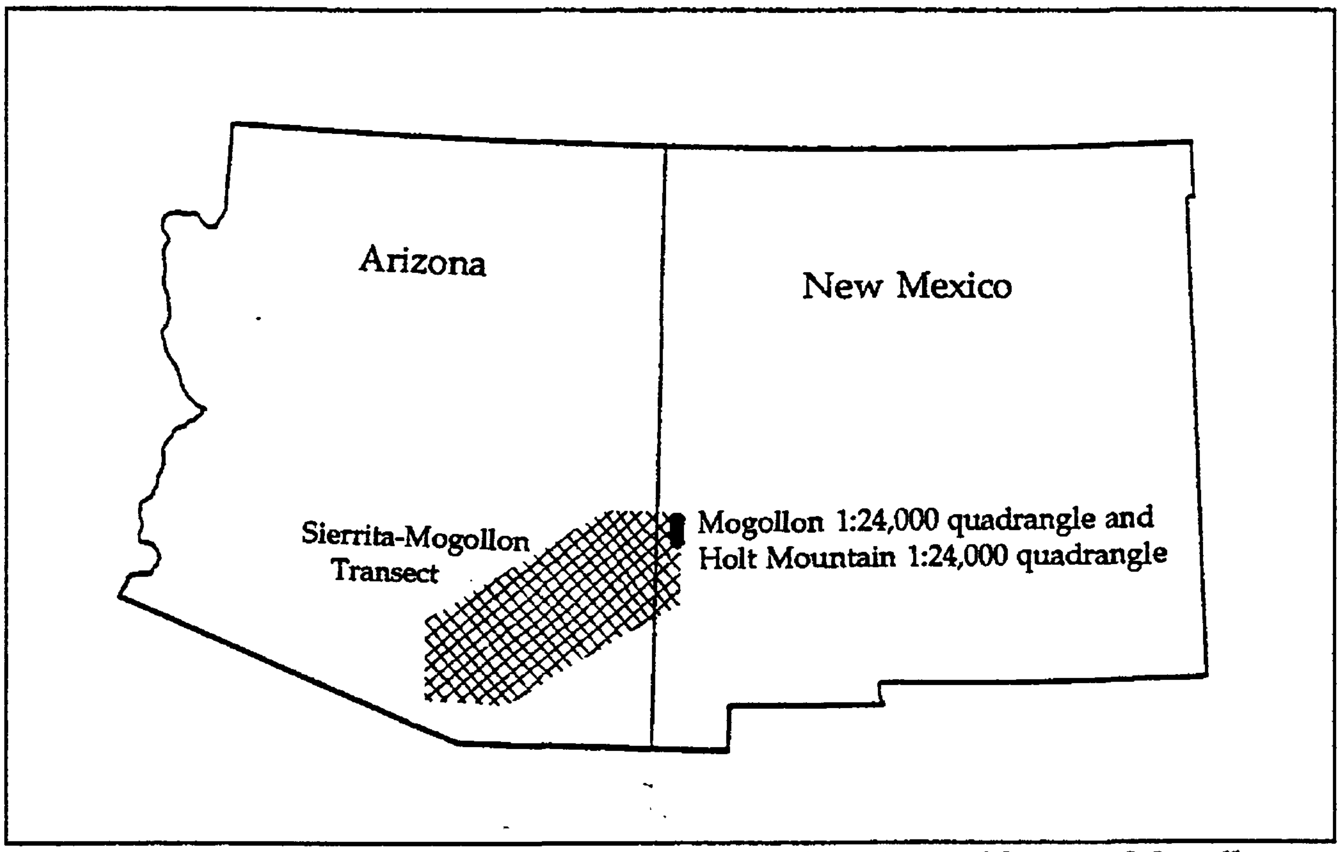

Figure 1. Arizona and New Mexico, showing locations of Sierrita-Mogollon transect and Mogollon and Holt Mountain quadrangles

SAMPLE DESCRIPTION

The Mogollon Mining District is located in the southern portion of the Mogollon quadrangle. Discovery of the district generally is credited to Sgt. James Cooney of the U.S. Cavalry, who staked the first claims in 1875 in Cooney Canyon; the discoveries at Mogollon were a result of the original find at Cooney. Between 1879, when the first ore was shipped to Silver City, New Mexico, for processing, and 1942, when the mines closed, an estimated 25 million dollars of silver, gold, copper, and lead were mined from quartz veins in the volcanic rocks (Ratté, 1981). Exploration and development in the district have continued on a sporadic basis to the present time.

In 1977 and 1978, a team of geochemists headed by K.C. Watts collected 186 samples of stream sediments in and around the Mogollon mining district in an area bounded by latitudes 33°21'00" to 33°30'00"N and longitudes 108°45'00" to 108°51'40"W as part of a study to determine geochemical exploration guidelines which would be useful for studying the remainder of the area. The results from samples that were processed as heavy mineral concentrates have been published (Watts and others, 1979); the report contains the data for both the non-magnetic and magnetic fractions which were obtained from each heavy-mineral concentrate. The archived samples that were retrieved from storage for this area were stream sediment samples collected concurrently with the heavy-mineral-concentrate samples from the same active alluvium.

The extreme western portion of the Gila Wilderness is located in the area covered by the Holt Mountain quadrangle. A few samples from this quadrangle were collected by K.C. Watts as part of the Mogollon study; the remainder were collected by J.C. Ratté as part of mineral resource studies of the Gila Wilderness conducted under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964). Results from rock, stream sediment, and heavy-mineral-concentrate samples collected for the entire wilderness area are given in U.S. Geological Survey Bulletin 1451 (Ratté and others, 1979). Of all these sample types, only the stream sediment samples that had been collected in the Holt Mountain quadrangle were retrieved from storage for additional chemistry.

Stream sediments reflect the composition of rocks and other materials that have eroded from the drainage basin upstream of the sample site. The samples from these two quadrangles were collected from first-order (unbranched) and second-order (below the junction of two first-order) streams as shown on USGS 1:24,000 topographic maps. The sizes of the basins covered by the stream sediment samples ranged from less than 0.5 mi^2 for some small gullies to about 2 mi^2 for some samples collected in second-order streams. In the Mogollon quadrangle each sample was collected at an oblique angle to the active stream channel, and across its full width; a number of subsamples were composited to form the sample. In the Gila Wilderness study, which included the Holt Mountain samples, the finest alluvium available at the site was collected. In both quadrangles the collection of samples generally was limited to streams and drainages in the mountainous parts of the quadrangles where the collected material would be representative of the area and close to its sources. Each sample from both sets was air-dried and sieved to minus 80 mesh (0.18 mm) using a stainless steel screen. The portion of the sediment passing through the screen was saved for analyses.

The archived samples that were selected for additional analyses were chosen to give reasonably uniform areal coverage of these quadrangles; however, some of these samples did not contain sufficient material for the analyses so that additional chemistry was completed on 84 samples from the Mogollon quadrangle and 54 samples from the

Holt Mountain quadrangle. The samples as received from storage were a mixture of samples that had been ground after sieving and those that had not been ground. All unground samples were split into 2 fractions and one-half of the sample was pulverized between ceramic plates to 100 mesh (0.15 mm) or finer before proceeding with the analyses.

SAMPLE ANALYSES

The stream sediment samples were analyzed for gold (determined by graphite furnace atomic absorption spectroscopy) and for copper, lead, zinc, silver, cadmium, and bismuth (determined by flame atomic absorption spectroscopy). Brief descriptions of the methods that were used are given below.

Graphite furnace gold:
Normally, 5 or 10 grams of sample are used for gold analyses in order to obtain a representative sample and minimize the effects of particulate gold. However, many of these samples contained a limited amount of material so the gold content was determined using only 2 grams of sample. The gold present in the sample was solubilized by heating with hydrobromic acid-bromine solution, and the gold bromide complex was extracted from the acid into methyl isobutyl ketone. Iron, which also extracted into the ketone and which interfered in the estimation of the gold content, was removed by back-extracting with 0.1N HBr. An aliquot of the methyl isobutyl ketone solution containing the gold was atomized in the graphite furnace of an atomic absorption spectrophotometer. The gold concentration of the samples was calculated from comparisons of the absorbance of each sample to that of standard gold solutions which were prepared in a similar manner. The lower limit of determination was 0.002 ppm (parts per million, 10^{-4} percent). Details of the complete procedure are given by Meier (1980).

Hydrochloric acid-hydrogen peroxide extractable metals (O'Leary and Viets, 1986):
This method was developed as a rapid, sensitive, and precise procedure for the determination of nine elements (arsenic, silver, bismuth, cadmium, copper, molybdenum, lead, antimony, and zinc) in geologic samples. One gram of material was treated with hydrochloric acid and hydrogen peroxide to solubilize metals that were not tightly bound in a silicate lattice of the stream sediment samples; this partial digestion solubilizes most sulfide, oxide, carbonate, and other nonsilicate minerals. The metals of interest were selectively extracted from the hydrochloric acid solution into a solution of 10% Aliquot 336 (tricaprylylmethylammonium chloride) in methyl isobutyl ketone. Ferric iron, which interfered in the estimation of the metal contents, was reduced to nonextractable ferrous iron with a solution of ascorbic acid and potassium iodide prior to the extraction step. The extraction of the metals into the organic solution removed interferences caused by the high levels of iron or calcium that commonly are present in geologic samples; it also concentrated the metals into a smaller volume of liquid and enhanced the sensitivity of the method. The lower limits

of determination for the six elements that were read from each solution are given in Table 1. Data obtained for arsenic and antimony have been discarded as unreliable due to a malfunctioning power supply that was used for these lamps. during the determinations; molybdenum was not read.

Table 1. Limits of determination for 6 elements
(All values in ppm.)

Bismuth	1 ppm
Cadmium	0.1 ppm
Copper	1 ppm
Lead	1 ppm
Silver	0.05 ppm
Zinc	1 ppm

QUALITY CONTROL

Geochemical reference samples prepared and issued under the auspices of U.S. Geological Survey and the Association of Exploration Geologists were used to monitor the accuracy of the analyses. The reference sample used for gold analyses was GXR-2, a composite soil collected in the Park City mining district, Summit County, Utah; the references samples used for the remaining analyses were GXR-5, a composite B-horizon soil collected in Somerset County, Maine, and GXR-6, a B-horizon soil from Davidson County, North Carolina, an area once active in gold and base metal mining. These reference samples were inserted into the analytical sequence and run concurrently with the stream sediment samples. The results from the current analyses and values obtained previously for the reference samples by these methods are listed in Table 2.

Table 2. Comparison of values for GXR reference samples
to previously obtained values
(All values in ppm.)

	GXR5			**GXR6**		
	Consensus values		These	Consensus values		These
Element	Range	Mean	data	Range	Mean	data
Cadmium	0.12-0.14	0.13	0.13	0.10-0.12	0.11	0.11, 0.15
Copper	320-330	330	317	63-65	64	67, 68
Lead	14	14	13	93-97	95	93, 99
Silver	0.71-0.73	0.72	0.73	0.32-0.34	0.32	0.31, 0.33
Zinc	41-43	41.6	45	104-106	105	100, 115
	GXR2					
Gold	0.020-.026	0.022	0.0155, 0.0157			

DESCRIPTION OF DATA TABLES

The analytical results for the Mogollon quadrangle are listed in Table 3; those for the Holt Mountain quadrangle in Table 4. Latitude and longitude are given in degrees, minutes, and seconds. All values are listed in parts per million (ppm, 10^{-4} percent). The letter "N" as a value indicates that the element was not detected at the lower limit of determination; if an element was detected, but was below the lower limit of determination, a "less than" symbol (<) was entered in the tables before the lowest value that is reported. Some samples did not contain sufficient sample material to complete the gold analyses even with the lower sample weight used in these analyses; leaders (--) instead of values are present in the results for gold for these samples. Determinations were made for bismuth on all samples. However, all results for bismuth were below the limit of determination of 1 ppm, and the columns for this element have been eliminated from Tables 3 and 4.

DATA STORAGE AND RETRIEVAL

Upon completion of the analytical work, the results were entered in the U.S. Geological Survey computer data storage system known as RASS (Rock Analyses Storage System). This database contains both descriptive geological information and analytical data; information from the database may be retrieved and converted to a binary form for computerized statistical analyses (VanTrump and Miesch, 1976).

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Table 3. Geochemical data for stream sediment samples from the Mogollon, New Mexico, 1:24,000 quadrangle.
[Au, N=N(.002); Ag, N=N(.05); -- = No data]

Sample	Latitude	Longitude	Au,ppm	Ag,ppm	Cd,ppm	Cu,ppm	Pb,ppm	Zn,ppm
ACA610	33 22 48	108 46 54	N	<.05	.1	20	30	40
77MO101	33 23 35	108 47 13	N	.05	.2	20	20	55
77MO103	33 23 32	108 46 40	N	N	.1	25	20	90
77MO105	33 23 31	108 46 32	N	.07	.2	25	18	65
77MO106	33 26 15	108 46 54	N	N	.1	18	14	50
77MO107	33 26 14	108 46 58	N	<.05	.2	40	15	65
77MO108	33 26 8	108 46 45	N	N	.1	19	18	90
77MO109	33 26 11	108 46 39	N	N	.1	30	20	85
77MO110	33 26 6	108 46 23	N	N	.1	50	8	85
77MO111	33 26 6	108 46 13	N	N	.1	20	12	75
77MO112	33 26 8	108 45 50	N	.05	.2	35	14	70
77MO113	33 26 1	108 45 36	<.002	.07	.2	30	11	60
77MO115	33 27 34	108 47 10	N	N	.2	40	12	60
77MO116	33 27 34	108 47 28	N	.20	.2	35	12	45
77MO119	33 27 16	108 48 38	N	N	.3	20	16	50
77MO120	33 27 11	108 48 43	N	<.05	.2	30	13	50
77MO121	33 27 13	108 48 58	N	N	.1	30	10	70
77MO125	33 23 13	108 48 8	.002	1.2	.4	30	35	40
77MO126	33 22 58	108 47 14	N	.10	.3	30	18	45
77MO128	33 22 49	108 47 15	N	.10	.2	30	25	45
77MO129	33 22 42	108 46 56	N	.15	.5	40	45	40
77MO130	33 22 47	108 46 59	N	.10	.2	45	20	65
77MO233	33 24 23	108 45 43	N	.15	.3	35	16	45
77MO235	33 24 48	108 46 45	.006	.30	.3	45	18	55
77MO236	33 24 57	108 46 50	N	N	.1	20	14	140
77MO237	33 25 0	108 47 24	.12	6.0	.2	40	25	60
77MO238	33 25 10	108 47 39	.020	2.7	.2	30	30	70
77MO239	33 25 3	108 47 41	.006	1.4	.4	75	25	65
77MO248	33 24 54	108 50 1	.004	.15	.2	25	10	55
77MO249	33 22 32	108 50 17	N	.05	.2	18	16	45
77MO250	33 22 37	108 50 0	.002	.10	.4	25	35	40
77MO251	33 23 6	108 49 36	<.002	N	.1	25	15	40
77MO255	33 24 15	108 48 28	1.5	45	.4	45	80	75
77MO256	33 24 18	108 48 6	.45	.85	.2	100	14	65
77MO257	33 24 11	108 48 46	.010	1.3	.3	50	19	60
78MO304	33 24 43	108 47 8	.004	.20	.2	25	25	35
78MO305	33 24 42	108 47 12	N	.15	.2	25	25	30
78MO311	33 24 34	108 48 39	.015	1.3	.2	45	25	55
78MO313	33 24 52	108 48 31	.010	.20	.2	60	15	50
78MO319	33 26 43	108 46 36	N	<.05	.2	25	13	60

Table 3. Geochemical data for stream sediments from the Mogollon, New Mexico, 1:24,000 quadrangle. (Continued)

Sample	Latitude	Longitude	Au,ppm	Ag, ppm	Cd,ppm	Cu,ppm	Pb,ppm	Zn,ppm
78MO321	33 26 39	108 49 8	N	<.05	.3	25	16	35
78MO323	33 26 39	108 47 37	.002	.05	.2	40	11	55
78MO325	33 26 29	108 47 22	N	<.05	.2	30	15	40
78MO327	33 26 45	108 45 33	.002	.05	.2	35	12	75
78MO333	33 25 40	108 47 24	.002	.07	.2	35	12	55
78MO334	33 25 41	108 47 18	.002	N	.2	35	12	70
78MO335	33 25 42	108 45 30	N	<.05	.2	25	14	65
78MO338	33 25 28	108 45 20	N	.07	.2	25	16	55
78MO340	33 25 41	108 46 3	N	N	.1	12	10	80
78MO341	33 25 55	108 48 55	N	.10	.4	55	10	55
78MO343	33 26 10	108 48 15	N	.10	.3	45	16	50
78MO344	33 28 37	108 47 22	N	.07	.2	60	10	60
78MO345	33 28 41	108 46 43	--	.07	.2	40	14	60
78MO346	33 29 11	108 46 31	N	.10	.3	55	14	55
78MO349	33 29 17	108 45 36	N	N	.1	14	5	35
78MO351	33 28 24	108 47 54	N	.05	.1	40	10	60
78MO353	33 28 5	108 47 2	N	<.05	.2	60	12	65
78MO354	33 28 4	108 46 51	N	<.05	.2	20	13	40
78MO357	33 27 46	108 48 15	N	<.05	.2	40	11	50
78MO400	33 22 40	108 45 38	N	.15	.2	18	15	35
78MO402	33 23 14	108 45 36	N	.05	.2	35	13	70
78MO406	33 23 41	108 50 11	N	N	.2	30	12	70
78MO407	33 23 34	108 49 2	.002	N	<.1	6	13	12
78MO408	33 23 11	108 48 58	<.002	.07	.3	20	20	20
78MO416	33 24 52	108 48 18	.012	1.2	.3	30	30	45
78MO417	33 24 50	108 48 21	<.002	.15	.2	25	30	25
78MO418	33 24 7	108 46 26	N	.15	.3	40	20	30
78MO419	33 24 16	108 45 6	N	.10	.4	30	20	25
78MO420	33 25 58	108 45 1	N	.07	.2	40	12	70
78MO424	33 26 4	108 48 2	N	.07	.2	40	12	55
78MO425	33 26 54	108 47 34	--	.07	.2	45	14	50
78MO426	33 26 51	108 47 13	N	.05	.2	25	14	40
78MO432	33 25 17	108 47 5	N	.10	.2	45	12	75
78MO433	33 25 32	108 47 3	N	<.05	.1	20	13	50
78MO434	33 25 5	108 46 33	N	N	.1	20	9	60
78MO437	33 25 39	108 46 15	N	N	.1	15	14	110
78MO439	33 26 13	108 47 46	N	.07	.2	45	12	65
78MO440	33 26 14	108 47 11	N	.10	.3	50	12	75
78MO443	33 27 31	108 46 9	N	N	.1	35	12	60
78MO446	33 27 30	108 45 12	N	.05	.2	30	11	65
78MO447	33 27 33	108 45 24	N	N	.1	40	12	55
78MO449	33 28 5	108 46 37	N	N	.1	25	12	50
78MO450	33 28 4	108 46 33	N	N	.2	35	14	60
78MO451	33 28 9	108 47 44	N	<.05	.1	40	14	60

Table 4. Geochemical data for stream sediments from the Holt Mountain, New Mexico, 1:24,000 quadrangle.
[Au, N=N(.002); Ag, N=N(.05); Cd, N=N(.1); -- = No data]

Sample	Latitude	Longitude	Au,ppm	Ag,ppm	Cd,ppm	Cu,ppm	Pb,ppm	Zn,ppm
ACA605	33 16 25	108 49 47	N	N	.1	45	14	50
ACA606	33 16 28	108 49 54	<.002	N	.1	40	16	55
ACA617	33 16 10	108 48 13	N	<.05	.1	30	20	55
ACA622	33 15 16	108 49 15	N	<.05	.1	30	15	50
ACA623	33 15 16	108 49 22	.004	N	.1	35	35	50
ACA626	33 15 32	108 47 50	N	<.05	.3	35	30	50
ACA811	33 16 35	108 49 59	<.002	.05	.1	45	15	60
ACA812	33 16 55	108 50 39	N	<.05	.1	14	18	30
AGR115	33 19 15	108 52 0	.004	N	.1	13	18	35
AGR116	33 18 58	108 49 8	.006	.10	.2	16	25	45
AGR121	33 19 30	108 51 40	.004	N	.1	12	17	30
AGR125	33 19 31	108 50 50	.006	<.05	.1	12	13	25
AGR127	33 20 4	108 51 4	.002	N	.1	7	11	16
AGR128	33 20 47	108 50 47	.004	N	.1	6	13	16
AGR133	33 19 52	108 48 50	--	.07	.2	13	20	18
AGR136	33 19 45	108 49 30	.006	.05	.2	10	17	25
AGR137	33 19 31	108 49 42	.004	N	.1	15	20	35
AGR138	33 19 30	108 49 42	.015	.05	.2	20	20	35
AGR140	33 19 26	108 50 23	.004	N	.1	10	17	24
AGR142	33 17 37	108 49 23	.004	.10	.2	50	18	55
AGR147	33 16 41	108 51 41	.002	N	.1	7	8	20
AGR149	33 17 3	108 51 20	N	N	.1	30	15	45
AGR151	33 17 32	108 51 57	.002	N	.1	9	11	25
AGR152	33 17 56	108 51 36	.002	N	.1	13	15	30
AGR160	33 18 19	108 52 20	N	N	.1	12	17	100
AGR162	33 18 29	108 52 8	.002	N	.1	8	10	25
AGR168	33 20 16	108 50 54	.004	N	.1	7	12	20
AGR171	33 21 10	108 50 41	.002	N	.1	5	13	13
AGR172	33 21 35	108 50 33	.002	<.05	.1	5	18	20
AGR173	33 20 12	108 50 18	.002	N	.1	8	13	25
AGR182	33 21 17	108 45 21	.030	<.05	.1	6	14	40
AGR183	33 21 11	108 45 4	.004	N	.1	6	13	35
AGR185	33 21 25	108 45 34	.020	.05	.1	7	16	40
AGR187	33 21 32	108 47 3	.060	.07	.2	30	20	70
AGR188	33 21 33	108 47 5	.002	N	<.1	8	15	50
AGR193	33 22 0	108 48 15	.002	N	.2	30	30	55
AGR194	33 21 56	108 48 14	.006	<.05	.1	12	14	45
AGR213	33 16 33	108 48 57	.002	N	.1	60	20	50
AGR219	33 15 23	108 50 25	.004	N	.1	30	18	45
AGR220	33 15 18	108 50 23	.004	<.05	.1	20	15	35

Table 4. Geochemical data for stream sediment samples from the Holt Mountain, New Mexico, 1:24,000 quadrangle. (Continued.)

Sample	Latitude	Longitude	Au,ppm	Ag,ppm	Cd,ppm	Cu,ppm	Pb,ppm	Zn,ppm
AGR235	33 15 48	108 45 27	<.002	.10	.3	20	25	55
AGR237	33 15 33	108 45 34	.002	.07	.3	16	30	80
AGR545	33 20 43	108 47 8	N	<.05	.1	8	20	30
AGR546	33 20 38	108 47 11	N	.05	.1	9	16	30
AGR548	33 19 9	108 46 8	N	N	<.1	8	20	40
AGR549	33 19 11	108 46 3	<.002	.07	.2	20	20	45
AGR550	33 19 14	108 46 7	<.002	.10	.2	10	25	30
AGR645	33 19 14	108 45 46	--	.05	.1	5	25	40
AGR693	33 16 5	108 46 36	N	.05	.2	18	15	30
AGR694	33 16 5	108 46 39	N	.05	.2	15	16	35
AGR761	33 16 27	108 45 24	N	N	N	6	11	25
78HM101	33 22 26	108 45 6	N	.10	.2	25	30	30
78HM103	33 21 15	108 45 27	11	.20	.3	30	30	35
78HM202	33 21 33	108 47 9	.004	N	.1	45	20	70