United States Department of the Interior

Geological Survey

Methodology, geology and listing of analyses of helium samples in the Bisti, De-Na-Zin, and Ah-Shi-Sle-Pah Wilderness Study Areas, San Juan County, New Mexico

by

Josh M. Been, Jerry R. Hassemer and Donald G. Murrey

Open-File Report 84-349

1984

CONTENTS

ABSTRACT

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U. S. Geological Survey and the U. S. Bureau of Mines to conduct mineral surveys on certain areas to determine their mineral resource potential. Results must be made available to the public and submitted to the President and the Congress. This report presents the results of a helium geochemical survey of the Bisti, De-Na-Zin, and Ah-Shi-Sle-Pah Wilderness Study Areas, San Juan County, New Mexico.

INTRODUCTION

A reconnaisance geochemical survey was made of the Bisti, De-Na-Zin, and Ah-Shi-Sle-Pah Wilderness Study Areas San Juan County, New Mexico. The chief purpose of this investigation was to provide a geochemical basis for a mineral resource appraisal in the three study areas. This report briefly presents the procedures and methods of the helium sampling program, and a complete listing of the data.

LOCATION AND GEOGRAPHIC SETTING

The Bisti, De-Na-Zin and Ah-Shi-Sle-Pah Wilderness Study areas together comprise about 50 square miles in the southwest corner of San Juan County, New Mexico, and lie about 31 miles south of Farmington (see fig. 1). Elevations range from 6792 feet above sea level in De-Na-Zin, to 5900 feet above sea level in Ah-Shi-Sle-Pah, providing a topographic relief of about 885 feet in this area. The ground surface is a gently sloping, highly dissected plateau cut by entrenched intermittent streams. Interstream uplands are blanketed by extensive fields of stabilized sand dunes.

The three areas are principally badland areas of uniquely shaped and sculpted erosional features, sharply incised steep-sided mesas, sand dunes and sand choked arroyos.

GEOLOGIC SETTING

The three wilderness study areas occupy the southwest corner of the San Juan Basin, which is an asymmetric northwest-southeast trending structural depression containing sedimentary rocks as thick as 14,100 feet ranging in age from Cambrian to Holocene. Only Upper Cretaceous or younger rocks are exposed in the vicinity of the study areas. The Upper Cretaceous sequence represents sediments deposited on the western margin of a vast epeiric seaway and records intertounging of marine and nonmarine units reflecting three basin-wide transgressive-regressive cycles of deposition (Fassett and Hinds, 1971).

The marine Cliff House Sandstone formation contains the oldest rocks exposed in the near vicinity of the study areas, and represents the shoreline deposits of the last major transgression of the Cretaceous sea. The overlying Lewis Shale is a marine offshore deposit laid down in the expanded seaway. The final regression or contraction of the sea resulted in the deposition of the shoreline deposits of the Pictured Cliffs Sandstone and the overlying nonmarine Fruitland Formation, Kirtland Shale, Ojo Alamo Sandstone (Paleocene), and the Nacimiento Formation (Paleocene). Attaining an aggregate thickness of about 1800 feet in the study areas, the Fruitland and younger formations are composed mostly of interbedded paludal and fluvial sandstone, siltstone, and shale (Brown, 1983).

METHODS AND ANALYSES

Samples were collected for helium analysis through the use of a hollow steel probe driven 1 meter into the ground. After capping the probe with a rubber septum device and purging the probe of atmospheric air, the sample was withdrawn using a hypodermic syringe, and then injected into a stainless steel cylinder fitted with a vacuum valve. Samples were then run on a daily basis with a modified dupont mass-spectrometer. Samples were collected over a seven day period in October, 1981.

Soil-gas samples were analyzed for helium using a portable mass spectrometer tuned for a mass-to-charge ratio of 4. Instrumentation and procedures are described in Friedman and others (1976) and Reimer and others (1979).

HELIUM IN GEOCHEMICAL EXPLORATION

Helium is a naturally-occurring, stable decay-product of uranium and thorium. As a noble gas, helium does not react with the medium through which it passes. It can, however, be trapped by various barriers and frequently occurs with natural gas.

The use of helium as an exploration tool has lead to the discovery of radioactive ore deposits, oil and gas pools, and fracture zones associated with mineral occurrences (Eremeev and others, 1973; Dyck, 1976; and Pogorski and Quirt, 1979). In the San Juan Basin, for example, very high helium soil gas concentrations have been found over known uranium-ore deposits in the Ambrosia Lake district of the Grants mineral belt (Brady and Rice, 1977).

The distribution of helium in sediments is affected by the lateral flow of artesian water, variations in the sorptive capacity of the rocks, presence of hydrocarbons, and variations in permeability (Golubev and others, 1974). At the surface, additional factors can affect soil-gas helium content. These include barometric pressure, air temperature, wind speed, soil temperature and moisture, relative humidity and precipitation (Reimer and others, 1976; Reimer, 1980).

EXPLANATION OF DATA TABLES

Helium values presented in the report were obtained by subtracting the background valve of atmospheric helium at 5240 ppb (parts per billion) from the absolute value obtained by analysis. The sensitivity of this method is 10 ppb.

Latitude and longitude for each sample locality is shown in degrees, minutes and seconds in columns 2 and 3. Samples numbered 80 through 124 are from the Bisti area, samples 26 through 79 are from the De-Na-Zin area, and samples 1 through 26 are from the Ah-Shi-Sle-Pah area.

Sample Locations and Data Values with Respect to Air

Sample	Latitude	Longitude	He (ppb)
HE001	36 11 2	107 52 45	80
HE002	36 10 7	107 52 47	80
HE003	36 9 24	107 53 23	80
HE004	36 9 31	107 53 42	80
HE005	36 9 36	107 54 8	40
HE006	36 8 43	107 54 21	80
HE007	36 8 23	107 55 12	50
HE008	36 8 49	107 55 9	60
HE009	36 9 20	107 55 27	50
HE010	36 7 59	107 55 56	80
HE011	36 7 36	107 56 54	80
HE012	36 8 8	107 57 22	80
HE013	36 8 26	107 57 59	70
HE014	36 8 59	107 57 53	80
HE015	36 7 51	107 58 12	60
HE016	36 7 37	107 58 52	80
HE017	36 11 57	107 52 45	20
HE018	36 12 8	107 53 51	40
HE019	36 11 40	107 54 38	50
HE020	36 11 6	107 55 12	51
HE021	36 10 19	107 55 2	40
HE022	36 10 57	107 56 13	41
HE023	36 10 59	107 57 12	40
HE024	36 11 41	107 57 34	62
HE025	36 11 10	107 58 27	41
HE026	36 11 33	107 59 12	41
HE027	36 21 8	107 57 27	41
HE028	36 20 40	107 58 11	31
HE029	36 19 51	107 58 33	10
HE030	36 19 12	107 59 8	20
HE031	36 18 40	108 0 8	31
HE032	36 18 3	108 0 50	41
HE033	36 17 26	108 1 31	4
HE034	36 16 51	108 2 18	31
HE035	36 16 15	108 3 3	20
HE036	36 15 17	108 3 46	41
HE037	36 15 19	108 4 39	41
HE038	36 15 0	108 5 24	30
HE040	36 19 30	107 57 0	41
HE041	36 18 34	107 56 23	61

Sample Locations and Data Values with Respect to Air

Sample	Latitude	Longitude	He (ppb)
HE042	36 18 56	107 57 16	61
HE043	36 18 50	107 58 8	41
HE044	36 18 4	107 57 52	62
HE045	36 17 16	107 58 5	62
HE046	36 16 31	108 3 26	41
HE047	36 16 53	108 3 31	21
HE048	36 17 21	108 3 27	41
HE049	36 17 49	108 3 31	72
HE050	36 18 11	108 3 43	82
HE051	36 18 34	108 3 41	72
HE052	36 18 58	108 3 45	41
HE053	36 19 20	108 3 48	41
HE054	36 19 40	108 3 25	51
HE055	36 19 50	108 2 25	41
HE056	36 20 3	108 3 22	41
HE057	36 20 27	108 3 12	82
HE058	36 15 3	108 6 42	82
HE059	36 15 33	108 5 46	82
HE060	36 16 2	108 5 58	72
HE061	36 16 11	108 6 52	82
HE062	36 15 42	108 7 51	10
HE063	36 15 42	108 8 33	72
HE064	36 21 37	108 3 41	10
HE065	36 21 11	107 58 38	41
HE066	36 21 9	107 59 28	41
HE067	36 21 0	107 59 59	41
HE068	36 21 42	107 59 51	31
HE069	36 21 42	108 0 54	61
HE070	36 21 9	108 2 8	41
HE072	36 21 39	108 3 5	41
HE073	36 19 4	108 0 9	72
HE074	36 19 22	108 0 27	63
HE075	36 19 39	108 0 50	73
HE076	36 19 43	108 1 20	53
HE077	36 19 45	108 1 47	42
HE078	36 19 47	108 2 18	42
HE079	36 21 1	108 3 10	84
HE080	36 16 13	108 15 28	60
HE081	36 15 51	108 15 11	105
HE082	36 16 2	108 14 50	105

Sample Locations and Data Values with Respect to Air

Sample	Latitude	Longitude	He (ppb)
HE083	36 16 7	108 14 19	101
HE084	36 16 12	108 13 49	99
HE085	36 15 13	108 15 3	63
HE086	36 14 51	108 14 35	94
HE087	36 14 35	108 14 58	71
HE088	36 14 18	108 15 26	63
HE089	36 14 3	108 15 55	42
HE090	36 14 37	108 15 36	118
HE091	36 14 53	108 16 5	42
HE092	36 13 55	108 15 13	103
HE093	36 14 33	108 14 12	105
HE094	36 14 13	108 13 57	84
HE095	36 14 23	108 13 35	42
HE096	36 14 42	108 13 39	73
HE097	36 14 49	108 13 9	105
HE098	36 14 58	108 12 37	63
HE099	36 16 16	108 16 4	126
HE100	36 16 5	108 16 25	84
HE101	36 17 0	108 15 29	63
HE102	36 17 22	108 15 27	84
HE103	36 17 19	108 16 2	84
HE104	36 17 44	108 15 26	84
HE105	36 18 42	108 4 7	63
HE106	36 19 5	108 4 28	84
HE107	36 18 25	108 4 7	73
HE108	36 18 14	108 4 42	63
HE109	36 18 15	108 5 20	42
HE110	36 18 18	108 5 50	42
HE111	36 18 36	108 6 15	63
HE112	36 18 56	108 6 7	42
HE113	36 19 15	108 5 41	63
HE114	36 19 18	108 15 14	53
HE116	36 20 21	108 3 33	40
HE117	36 20 34	108 3 49	80
HE118	36 20 50	108 3 54	63
HE119	36 21 1	108 4 0	80
HE120	36 20 45	108 4 22	60
HE121	36 20 30	108 4 46	40
HE122	36 20 30	108 5 15	40
HE123	36 20 15	108 5 44	40
HE124	36 20 11	108 6 12	63

REFERENCES CITED

Brady, B. T., and Rice, R. S., 1977, Helium determinations as an exploration technique in the Ambrosia Lake uranium district, McKinley County, New Mexico: U. S. Geological Survey Open-File Report 77-669, 8 p.

Brown, J. L., 1983, Geologic and isopach maps of the Bisti, De-Na-Zin, and Ah-She-Sle-Pah Wilderness Study Areas, San Juan County, New Mexico: U. S. Geological Survey Miscellaneous Field Studies Map, MF-1508A, 2 sheets.

Dyck, W., 1976, The use of helium in mineral exploration: Journal Geochemical Exploration, v. 5, p. 3-20.

Eremeev, A. N., Sokolov, V. A., Solovov, A. P., and Yanitskii, I. N., 1973, Application of helium surveying to structural mapping and ore deposit forecasting, in Jones, M. J., ed., Geochemical Exploration, 1972: London, The Institution of Mining and Metallurgy, p. 183-192.

Fassett, J. E., and Hinds, J. S., 1971, Geology and Fuel Resources of the Fruitland formation and Kirtland shale of the San Juan Basin, New Mexico and Colorado: U. S. Geological Survey: Professional paper 676, p. 1-76.

Friedman, Irving, Denton, E. H., Roberts, A. A., and Reimer, G. M., 1976, A mobile helium sniffer for petroleum, uranium, and geothermal prospecting: Proceedings, 25th International Geological Congress, Sydney, N.S.W., v. 2, p. 443-444.

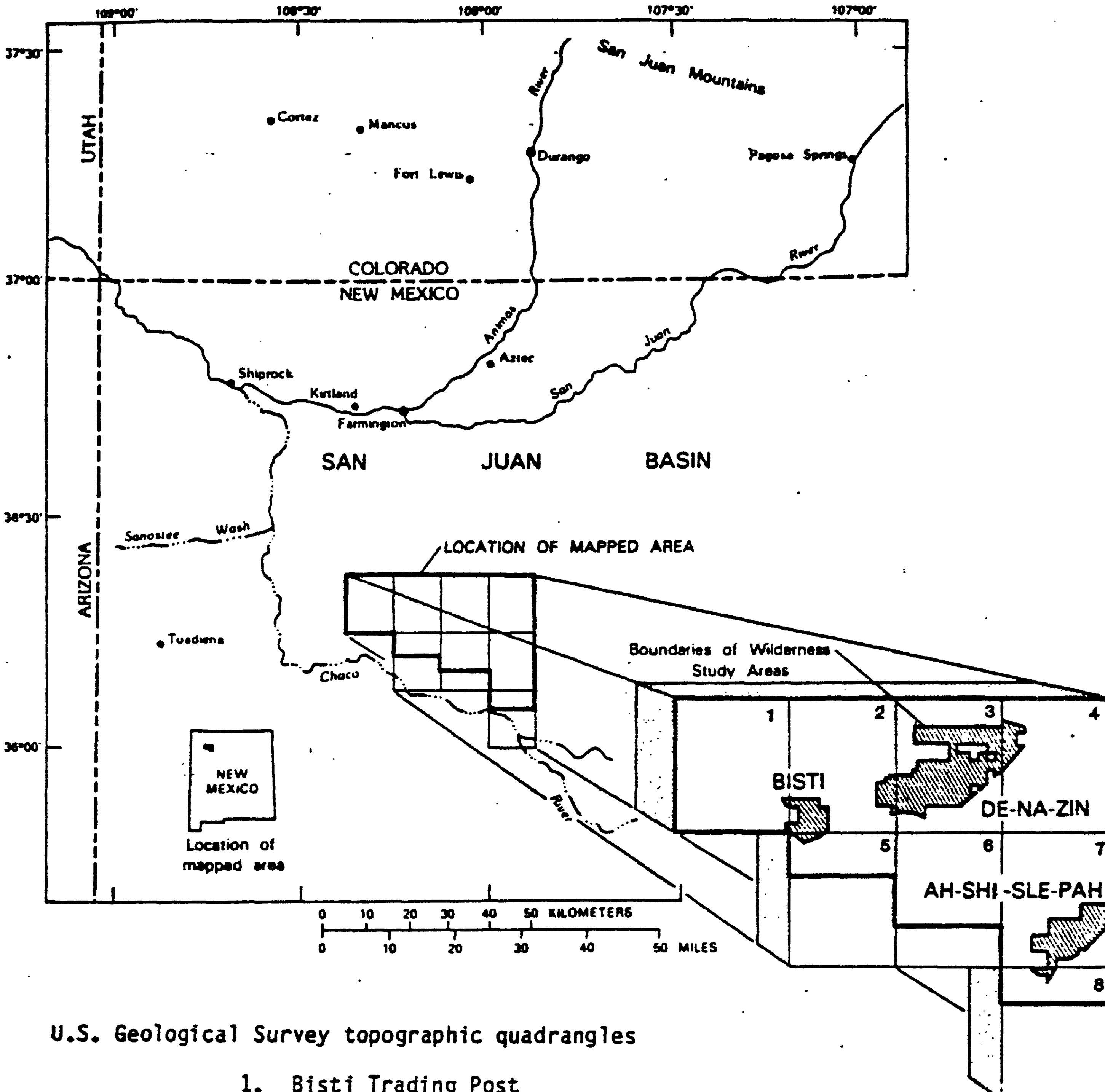
Golubev, V. S., Yeremeyev, A. N., and Yanitskiy, I. N., 1975, Analysis of some models of helium migration in the lithosphere: Geochemistry International, v. 11, no 4, p. 734-742.

Pogorski, L. A., and Quirt, G. S., 1979, Helium Emanometry as an indicator of deeply buried uranium deposits: Grand Junction, Colo., U. S. Department of Energy Open-File Report GJBX-22(80), 362 p.

Reimer, G. M., 1980, Use of soil-gas helium concentrations for earthquake prediction: limitations imposed by diurnal variations: Journal of Geophysical Research, v. 85, no. B6, p. 3107-3114.

Reimer, G. M., Denton, E. H., Friedman, Irving, and Otton, J. K., 1979, Recent developments in uranium exploration using the U. S. Geological Survey's mobile helium detector: Journal Geochemical Exploration, v. 11, p. 1-12.

Reimer, G. M., Roberts, A. A., and Denton, E. H., 1976, Diurnal effects on the helium concentration in soil gas and near-surface atmosphere: U. S. Geological Survey Open-File Report 76-715, 6 p.



U.S. Geological Survey topographic quadrangles

1. Bisti Trading Post
2. Alamo Mesa West
3. Alamo Mesa East
4. Huerfano Trading Post SW
5. Tanner Lake
6. Pretty Rock
7. Pueblo Bonito NW
8. Pueblo Bonito

Figure 1.--Index map showing location of Bisti, De-Na-Zin, and Ah-Shi-She-Pah Wilderness Study Areas.