UCRL- 91762
PREPRINT

ASCOT DATA FROM THE 1980 FIELD MEASUREMENT PROGRAM IN THE ANDERSON CREEK VALLEY, CALIFORNIA

Marvin H. Dickerson and Paul H. Gudiksen

This paper was prepared for presentation
at the Model Evaluation DOE/AMS Workshop,
October 23-26, 1984.

November 7, 1984

Lawrence Livermore National Laboratory

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Marvin H. Dickerson and Paul H. Gudiksen

Lawrence Livermore National Laboratory, University of California,
Livermore, CA 94550, USA

INTRODUCTION

The Department of Energy is currently sponsoring a program of Atmospheric Studies in Complex Terrain (ASCOT) to improve the technology needed to assess the air quality impacts of developing energy resources in areas of complex terrain. The program uses theoretical atmospheric physics research, mathematical models, and field experiments to help develop a modeling and measurements methodology that can be used to provide the air quality assessments in these areas.

With the program's initial focus being on the study of transport and dispersion of materials injected in or near nocturnal drainage flows, a series of exploratory field experiments of limited scope were conducted during July 1979 in the Anderson Creek valley of The Geysers geothermal area in northern California. The analyses of the results derived from these experiments provided initial insight into the structure of the drainage flows and permitted the design of a more comprehensive series of experiments that were conducted during September 1980 in the same valley. The experimental plan for the September 1980 studies consisted of five separate and identical experiments. Each experiment included multiple tracer releases that were coordinated with a series of meteorological measurements. The general objectives of these experiments were:

- Evaluate the entire nocturnal drainage cycle-initiation, perpetuation, and breakdown.
- Define the regional scale flows (30–50 km range) as well as the flows over the ridges surrounding the Anderson Creek Valley to permit an evaluation of the influence of these flows on the nocturnal drainage flows within the valley.
- Define, at least in a preliminary manner, the effect of surface roughness and forest canopy on the drainage flows.
- Define the temporal and spatial characteristics of the drainage flows within the valley.
- Define the evolution of pooling of drainage flows within the lower portions of the valley and subsequent outflow of this air into the Middletown area. This should include a characterization of the three- dimensional structure of this pool and an evaluation of the mechanisms responsible for draining the pool.
- Evaluate the exchange of mass between the nocturnal drainage flows and the over-lying transition layer.

This next section provides a listing of the meteorological and tracer data acquired during these experiments for evaluating the transport and dispersion characteristics associated with nocturnal drainage flows.

EXPERIMENTAL PLAN

Tracer Experiments

The specific objectives of the tracer experiments were to evaluate the transport and dispersion of materials injected into:

- Each of the major drainage areas within the Anderson Creek Valley, the same drainage are at two different sites up the slopes,
- the transition layer above the shallow drainage flows, and
- the drainage flows within a forest canopy.

To address these objectives required the use of several tracers released and sampled in a coordinated manner. The tracers utilized were:

- two perfluorocarbons,
- two heavy methanes,
- sulfur hexafluoride,
- oil fog tracked by Lidar, and
- tetroons tracked by radar.

The layout of the tracer release sites and the locations of the Lidar and radar systems are shown in Fig. 1. The gaseous tracers and the oil fog were released simultaneously over a one hour period after the nocturnal drainage flows had been established. All of the releases were at ground level except for one of the heavy methanes which was released into the transition flow above the shallow drainage layer. Since this layout did not include sequential releases of tracers we utilized the tetroon tracking radar system to evaluate the temporal variabilities in the transport characteristics throughout each experiment. Thus, tetroons were released from a variety of sites within the major drainage areas throughout the experimental periods.

An extensive network of surface samplers and two vertical profiling systems were deployed throughout the Anderson Creek Valley. Two types of surface samplers were utilized: (1) samplers with 10–20 minute sample averaging times to provide plume passage information; and (2) samplers collecting samples with averaging times of the order of several hours (Fig. 2). In addition, real-time sulfur hexafluoride and perfluorocarbon samplers were also utilized. The two vertical profiles consisted of balloon-borne sampling systems. One, consisted of a sampling cable, suspended from a tethered balloon to enable air samplers, located on the ground, to collect samples from various heights up to 1600 ft. above the surface. The other profiling system utilized on-board samplers collecting samples at specific height intervals as the balloon was hauled up and down. Several thousand samples were collected from the entire network during the five experiments.

Meteorological Measurements

The meteorological measurements systems dedicated to the experiments included acoustic sounders, tethersondes, lasers and optical anemometers, radiation sensors, soil temperature profile measurements, meteorological towers, an airborne multi-spectral scanner for surface temperature measurements, radiosondes, minisondes, and pressure sensors.

The layout of the acoustic sounders and the tethersondes are shown in Figs. 3 and 4. These measurements were specifically designed to address the general program objectives of (1) defining the spatial and temporal characteristics of the drainage flows, (2) characterizing the pooling of drainage flows, and (3) an evaluation of the mechanisms responsible for draining the pool out into the Middletown area. Thus, most of the instrumentation was situated within the lower parts of the valley, while one tethersonde was dedicated to defining the larger scale flows over the ridge.

A network consisting of 27 surface meteorological stations, capable of telemetering the measurements to a centrally located base station, supported the program. The primary purposes of this system were (1) to provide real-time displays of the surface winds throughout the study area that were needed for selecting the most desirable time to release the tracers, and (2) to provide a data base of surface winds and temperatures that can be utilized in the post analysis phase of the program. The layout of the network is shown in Fig. 5.

The optical paths, illustrated in Fig. 6 were designed to obtain spatially averaged wind speeds across the principal drainage areas, and, hence, the most likely tracer flow paths.

A long-term continuously operating network of 10 m meteorological towers also operated during the experiments. This network was augmented by a 60 m tower instrumented at several levels to provide detailed definition of the wind and temperature structure within the shallow drainage flows.

In addition, several other measurement systems were utilized. A triangular upper air measurements network was established to tie the measurements within the valley to the regional scale flows. An airborne infrared sensing system was used for measuring surface temperature gradients along the sloped surfaces. Finally, measurements of the ambient air concentrations of radon were made to assist in the categorization of the types of drainage flows observed during the experiments.

SUMMARY

The complete data set for the 1980 ASCOT field experiments is available from the Lawrence Livermore National Laboratory (Gudiksen, 1983). These data are also available from LLNL on magnetic tape (Phone (415) 422-1815 or FTS 532-1815). For the DOE/AMS Model Evaluation Workshop, SF6, PDCH and PMCH tracer concentration data measured by the network shown in Fig. 2 were available to participants. Wind and temperature data measured by the PAM towers (Fig. 5), nine 10 m and one 60 m towers (not shown) and tethersondes (Fig. 4) were also available to workshop participants.

ACKNOWLEDGMENTS

This work was performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

REFERENCES

Gudiksen, Paul H., editor, "ASCOT Data From the 1980 Field Measurement Program in the Anderson Creek Valley, California," University of California, Lawrence Livermore National laboratory, UCID-18874-80, Vols. 1, 2 and 3 (1983).

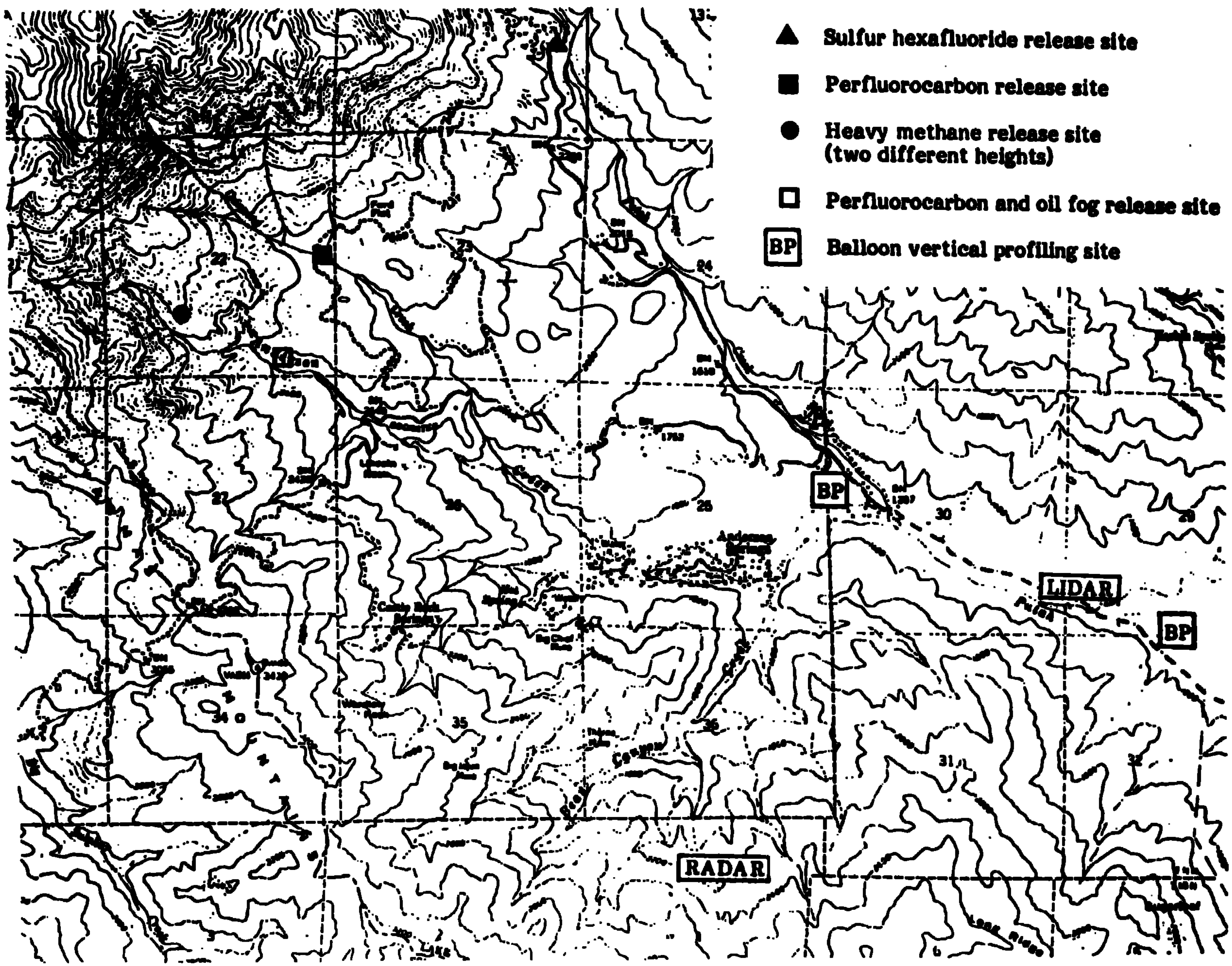

FIGURE 1. ASCOT tracer experiments.

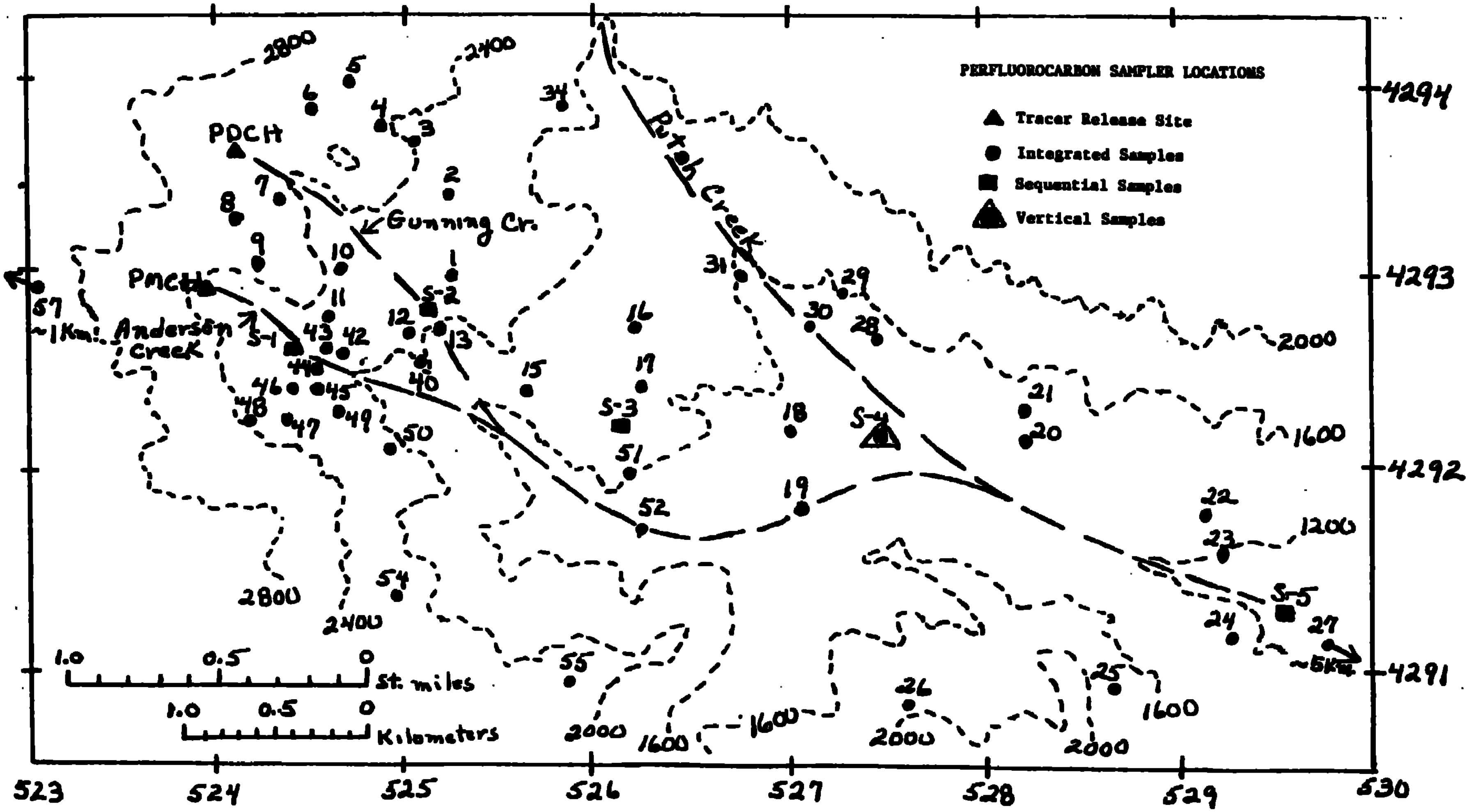

FIGURE 2. Perfluorocarbon sampler locations.

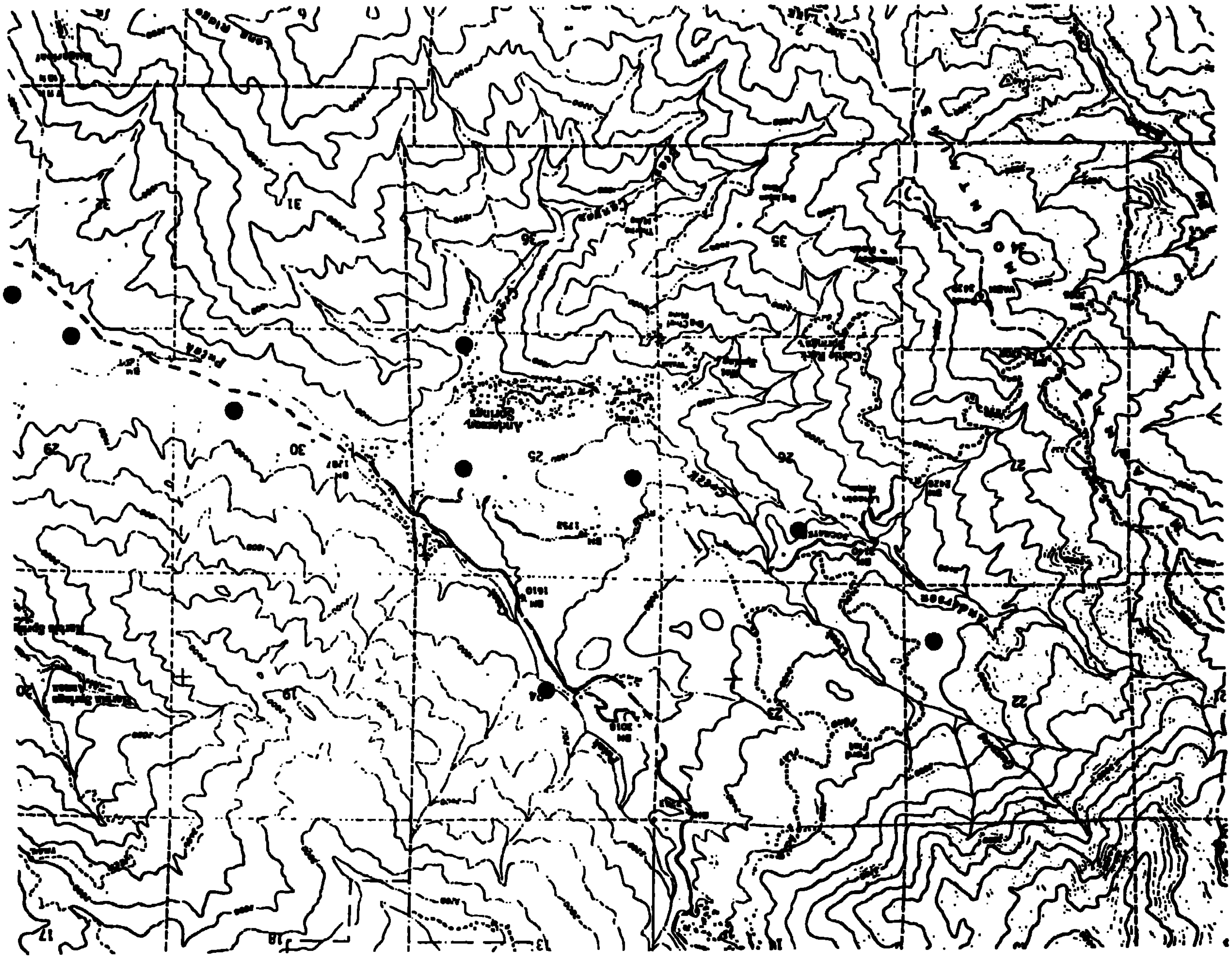

FIGURE 3. Acoustic sounder locations.

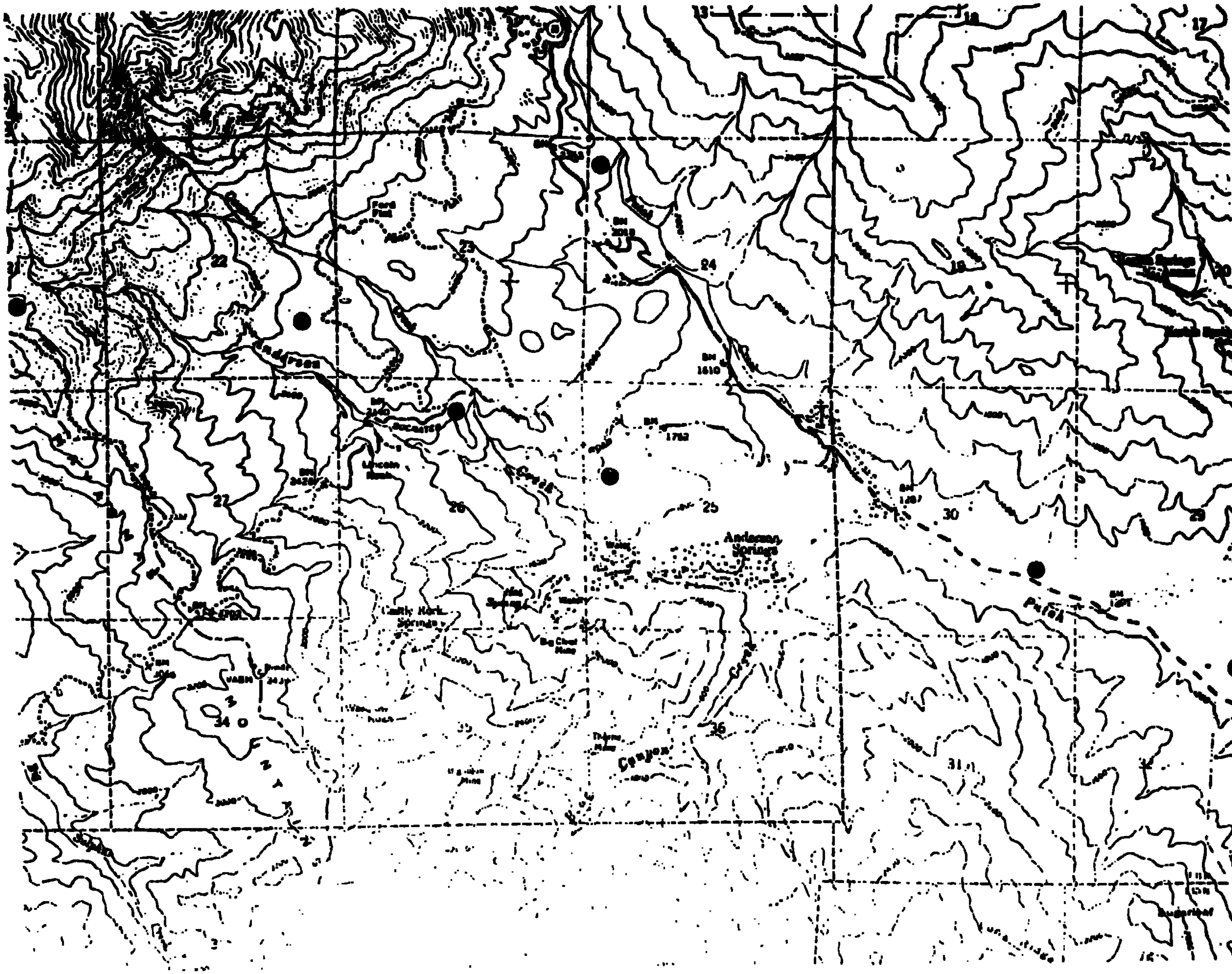

FIGURE 4. Tethersonde locations.

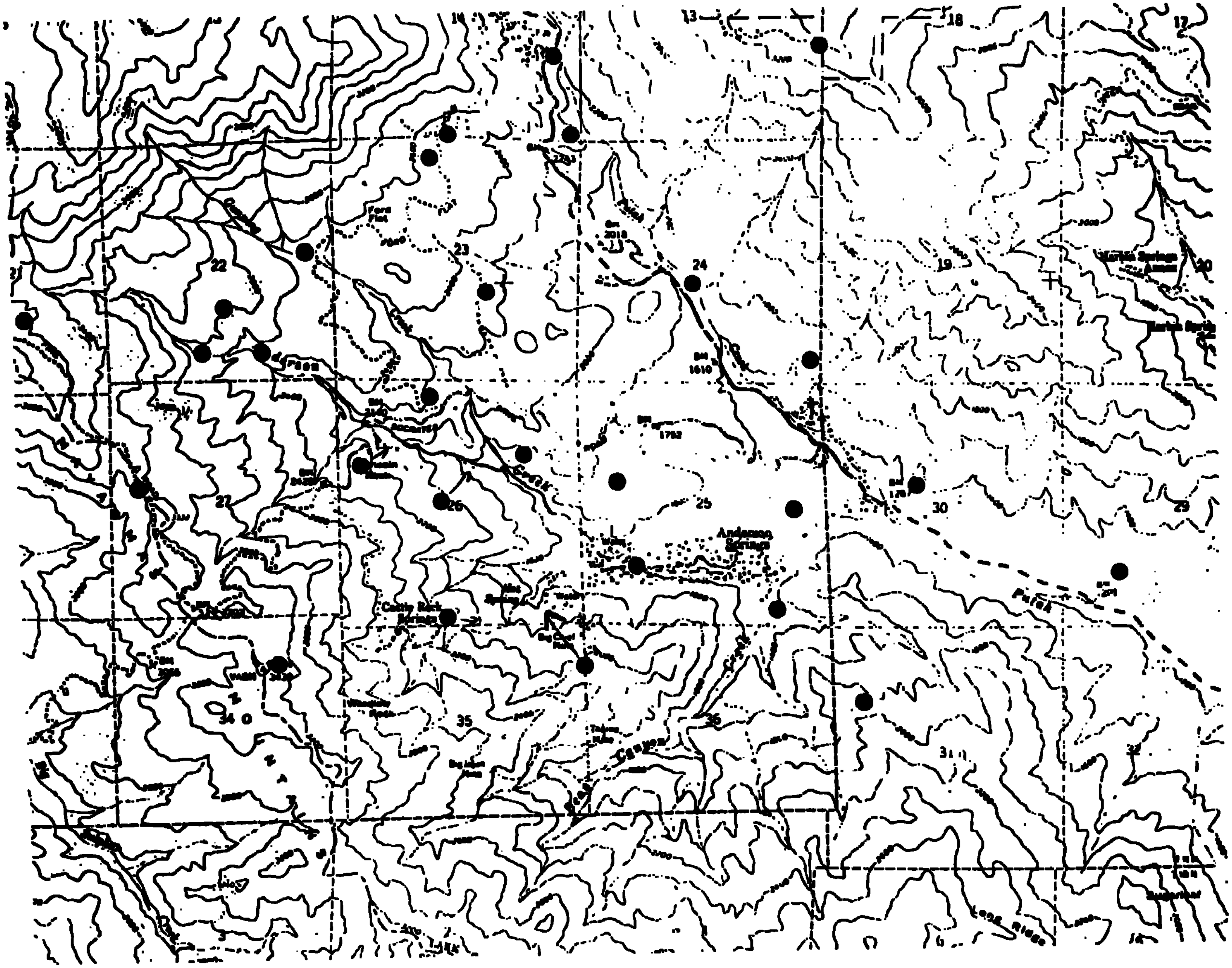

FIGURE 5. Surface meteorological stations telemetering data in real-time to base station.

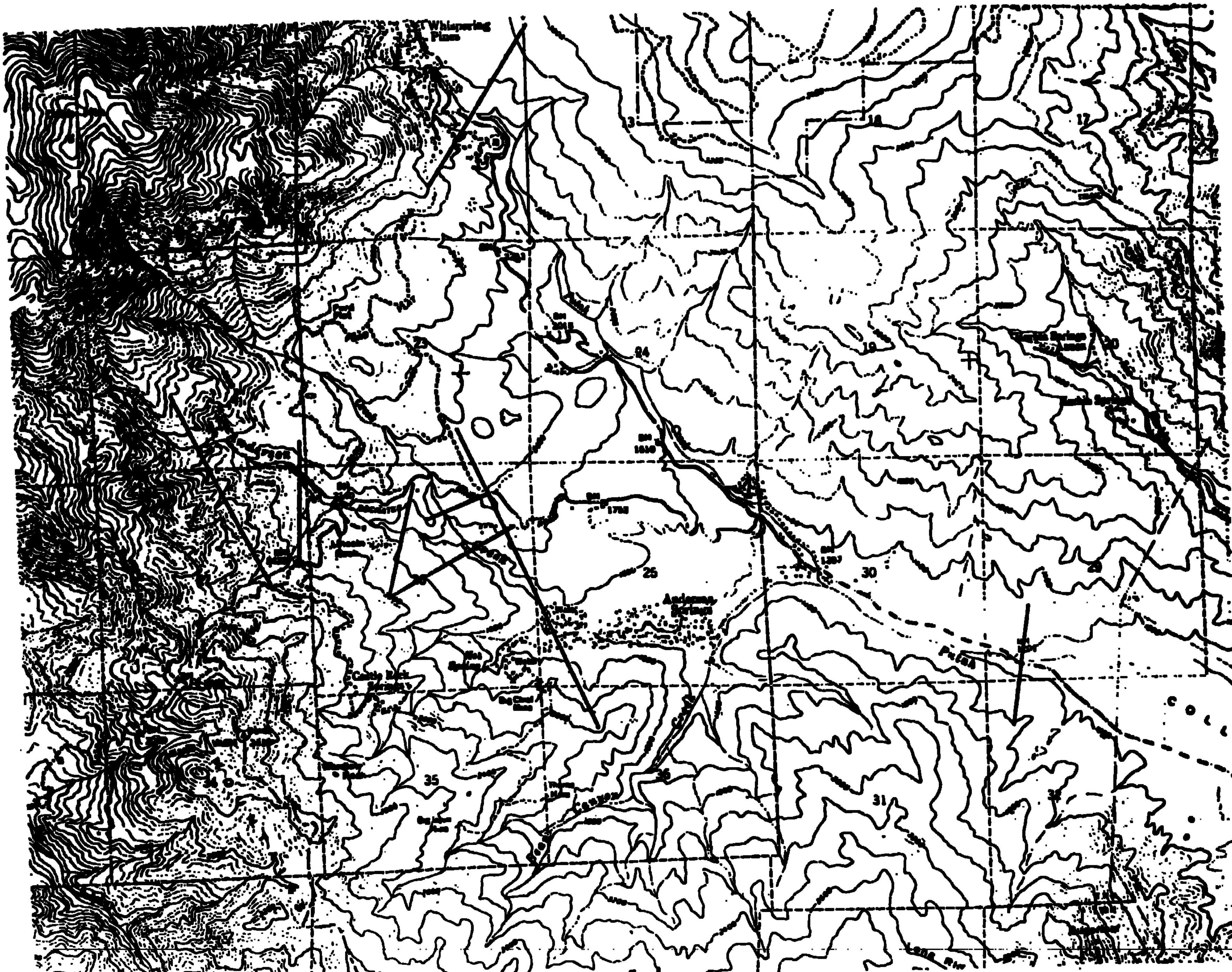

FIGURE 6. Optical paths.