ATTACHMENT 1

MAY 17 1990

NOTE FOR: David Brooks

FROM: Keith I. McConnell KIM
King Stablein KIS

SUBJECT: PHASE I REVIEW OF ACTIVITY 8.3.1.4.2.2.2 - SURFACE FRACTURE-NETWORK STUDIES

The Geology-Geophysics Section's effort in the Phase I review of Activity 8.3.1.4.2.2.2 has indicated that there may be a waste isolation/test interference concern associated with this activity.

Generally, the concern relates to the use of water to clear pavement exposures for this activity. The activity plan indicates that analyses (SCP Section 8.4) have shown that the use of water to clear pavement exposures is not a waste isolation concern. The activity plan also states that a final evaluation of the interference potential of this activity is not currently possible because test locations have not been firmly established. In order for the Geology-Geophysics Section to complete its Phase I review, we need to know if the HT Section agrees with the assessment that these activities will have no impact on waste isolation. We also need to know if the lack of firmly established test locations and resultant lack of an assessment of the possible interference with other (hydrologic) tests constitutes a concern serious enough to warrant NRC staff action.

Keith has attached pertinent sections of the activity plan to this note. The PPSAS # and TAC # are 411431, L64333. We request that members of your section look over the planned tests related to this activity and assess whether the test methods do constitute either a waste isolation concern or test interference concern.

The Geology-Geophysics Section's current deadline for completion of the Phase I review on this activity is COB Friday, June 1, 1990. If your review effort might significantly affect our ability to meet this milestone, please let Keith know.

cc. R. Ballard
P. Justus
K. Stablein
J. Linehan

ATTACHMENT

2.2 Activity 8.3.1.4.2.2.2 Surface fracture-network studies

This activity will gather detailed information on fracture properties in the volcanic bedrock units exposed at the surface of Yucca Mountain. These data will be integrated with information gathered in other activities in this study (investigations of regional surficial and local subsurface fractures).

2.2.1 Rationale for the types of tests selected

Three test methods were considered for surface fracture studies: 1) bedrock-pavement (pavement method), 2) uncleared-outcrop method (outcrop method), and 3) photogeologic method. For the pavement method, cleared bedrock surfaces are mapped, and fracture parameters (table 2.2.1) are recorded. For the outcrop method, fracture parameters are recorded from natural outcrops. For the photogeologic method, linear features are mapped from aerial photographs by means of a stereoplotter. The pavement and outcrop methods (sec. 3.2.2) were chosen as complementary means for obtaining the required information on fractures. The photogeologic method was rejected on the basis of early prototype testing, but may be tested again in modified form if larger-scale photographs become available. The bases for selecting the methods are discussed below.

The planned test methods complement each other, in that the pavement method provides more complete data locally and the outcrop method allows for more widespread observations. (In general the methods do not gather data at the same locations.) Similarly, the pavement method provides data on fracture network properties (i.e., trace length, connectivity, spatial distribution) that can be obtained only by mapping the fracture traces, whereas the outcrop method generally provides only orientation, aperture, roughness, and mineral filling data, but may yield trace-length data where exposures are adequate and photographs are available for plotting. The pavement method can be used only on natural pavements or where debris is thin and readily cleared the location is accessible to the equipment needed for clearing, whereas the outcrop method can be used wherever there are natural exposures.

2.2.1.1 Uncleared-outcrop tests

Fractures are to be studied in natural outcrops because such exposures are widespread and allow for observations in many of the volcanic units at Yucca Mountain. Four of the seven required parameters (orientation, aperture, roughness, and fracture fillings) can be studied at outcrops. The incomplete exposure of natural outcrops precludes study of the fracture network (connectivity and spatial distribution).

2.2.1.2 Pavement tests

In order to obtain the required parameters that cannot be obtained from uncleared-outcrops, fractures also will be mapped on bedrock pavements. Whether natural or cleared by man, bedrock pavements that are entirely free of regolith and vegetation offer an opportunity to study, map, and measure

fracture networks in two dimensions. If the pavement is large enough and properly situated, all seven of the parameters of this activity are obtainable. However, the traces of one type of fracture, faults, extend well beyond any expected pavement, and their length must be measured on geologic maps (Activity 8.3.1.4.2.2.1). Completed pavements range from 150 m^2 (1,615 ft^2) to 2,000 m^2 (21,500 ft^2 or nearly 0.5 acre).

2.2.1.3 Photogeologic mapping

In prototype tests of the photogeologic alternative (Throckmorton, 1987), most fracture traces were not discerned, because the quality of exposures was too poor and the photographic scale, though large (1:2,400), was too small: 66-87 percent of the fractures observed directly in the field were not detected on the photos. In addition, trace bearings and lengths measured on the photos differed from those measured in the field, indicating that many traces mapped from the photos represented lineations other than fractures.

2.2.2 Rationale for the number, location, duration and timing of the selected tests

2.2.2.1 Number

The number of tests anticipated for this activity (table 2.2-2) is determined by what is required for the mapping, measuring, observing, and sampling of fracture-network characteristics from exposures at the surface of Yucca Mountain. Throughout this activity a phased approach will be employed whereby the results from sites already studied in a given unit will be considered in determining the need for additional data from that unit.

The number of pavements to be studied is limited because few locations have adequate exposure and ready accessibility for clearing equipment. Seven sites have been completed to date (fig. 2.2-1), each yielding data from about 100 to 1,000 fractures.

The upper lithophysal unit of the Tiva Canyon Member will be the most extensively studied because it occupies approximately 60 percent of the surface area of Yucca Mountain and, therefore, is the most subject to infiltration of snow-melt and rain and is, by virtue of its extensive exposures, rich in evidence of the relative ages of fractures.

2.2.2.2 Location

Locations are chosen to provide lateral coverage and vertical sampling through the stratigraphic section exposed at the surface of Yucca Mountain. Pavement sites are limited to locations where debris cover is thin and where clearing equipment can operate. Outcrop sites are selected to provide systematic coverage of data from these surface-fracture network studies. Location of existing and potential pavement sites at Yucca Mountain are shown in figure 2.2-1.

The number of sites studied in each unit will be approximately proportional to its extent. Consequently, more sites will be located in the

Tiva Canyon Member of the Paintbrush Tuff, as it is the most widely exposed unit in the Yucca Mountain area.

2.2.2.3 Duration

The duration of the tests is dictated by the time required for making detailed field observations at the outcrop sites, mapping the pavement sites, and compiling and reducing the data. Typically, data from a single outcrop can be obtained in two or three days. Cleaning, mapping, and data collecting from a single pavement requires approximately eight weeks. However, production-line methods, and possibly the use of photogrammetric techniques, will appreciably decrease the average time required for each of a series of pavement studies.

2.2.2.4 Timing

Because the selection of pavement and outcrop sites depends in part on data from geologic mapping (Activity 8.3.1.4.2.2.1), the fracture studies were begun after that mapping was well underway. The schedule for future studies is dictated by the need to provide information to other activities, especially those involved in exploratory shaft and drift tests. (See secs. 4 and 5.)

Surface fracture-network studies are in part dependent upon data from geologic mapping (Activity 8.3.1.4.2.2.1) for efficient site selection. As that mapping is now completed, this activity is in line to move forward toward completion so that fracture data, data-handling techniques, and fracture-network concepts can be provided to other activities, especially those involved in exploratory shaft and drift tests.

2.2.3 Constraints: factors affecting the selection of tests

In terms of the nine factors discussed below, the methods planned for this activity have been found to yield the required parameters most efficiently and accurately.

2.2.3.1 Impacts on the site

Section 8.4.2.2.2 of the Site Characterization Plan describes those surface-based activities which may impact the ability of the site to isolate waste. Water usage during the clearing of pavements is the only aspect of this activity which may affect waste isolation characteristics at the site. As presently planned, two additional pavement studies might be conducted in the repository block within the area outlined by the perimeter drift (fig. 2.2-1).

The effects of water usage during site characterization on the performance of the site was analyzed in sections 8.4.3.2.5.1 and 8.4.3.3 of the Site Characterization Plan. Although water usage by this activity was not explicitly considered by these analyses, the water volume required for clearing of two pavements is small in comparison to the bounding analyses presented in section 8.4.3.3, and in comparison to the volumes of water which

will be introduced by natural precipitation and other site activities (e.g. dust suppression, artificial infiltration study).

Based on these analyses, it appears that the introduction of water at the surface in conjunction with pavement preparation during this activity will have no effect on the ability of the site to isolate waste. Nevertheless, water usage for clearing pavements will be kept to a minimum. In order to limit the amount of water used, a mixture of water and compressed air (foam method) will be used in clearing pavements if an adequate compressor can be made available at the selected site.

2.2.3.2 Simulation of repository conditions

Not applicable: none of the study methods would attempt to simulate repository conditions.

2.2.3.3 Required accuracy and precision

The accuracy required in surface fracture network studies has not been determined; it was not a factor in selecting test methods. As fractal dimensions from subunits of the tuff sequence are expected to differ only slightly, the required accuracy of field measurements will be high to ensure that the slight differences are meaningful. Close-range photogrammetry may be required to largely eliminate errors emanating from field judgments and human bias, as well as to assist in rectifying measurements from nonplanar pavements.

Required accuracy, by definition, relates to generating data trends that are significant.

The tools and equipment used in these tests are standard and are designed to yield precision within acceptable tolerances. In order to assure consistency, pavement and outcrop study methods were selected partly because essentially the same equipment is used in each.

2.2.3.4 Limits of analytical methods

The planned test methods were selected because they will provide the required parameters for the analyses discussed in section 4. Several computer programs are being written to assist in analysis. Statistical evaluation and validation of field methods (data collecting) and of fractal analyses will be required to determine whether planned tests yield reproducable, significant results.

2.2.3.5 Capability of analytical methods

Not a factor in selecting study methods. Standard analytical and data-reduction methods will be used; most will be computer assisted.

2.2.3.6 Time Constraints

The largely standardized outcrop and pavement methods, and potentially the photogeologic method, were selected in order to get the study under way as early as possible to gain experience in data collecting prior to the beginning of complementary shaft and drift mapping. Techniques developed in this activity will be adopted at least in part by other activities.

2.2.3.7 Scale and applicability

Not applicable: alternative methods and types of equipment would not have affected the potential for extrapolating the measurements and observations.

2.2.3.8 Interference with other tests

The interrelationships of surface and sub-surface based activities are described in section 8.4.2.2 of the Site Characterization Plan. It is not currently possible to perform a final evaluation of the interference potential of this activity, since the location of future pavement areas have not been firmly established.

The most probable source of interference, if it exists, might arise from the use of water during clearance of pavements. Introduction of water at the surface could interfere with near-surface hydrologic monitoring or gas-phase circulation studies. All water used during pavement clearance will be tagged with non-toxic chemical tracers, allowing identification of water introduced during this activity, and providing a basis for correcting for interference effects, if they occur.

Pavement localities will be selected such that interference with other tests will be avoided or minimized. Tagged water used in clearing pavements will be kept to an absolute minimum. In order to limit the amount of water used, a mixture of water and compressed air (foam method) will be used in clearing pavements if an adequate compressor can be made available at the selected site.

2.2.3.9 Interference with exploratory shaft

These tests, irrespective of test method selected, do not interfere with or have the potential to interfere with the exploratory shaft.

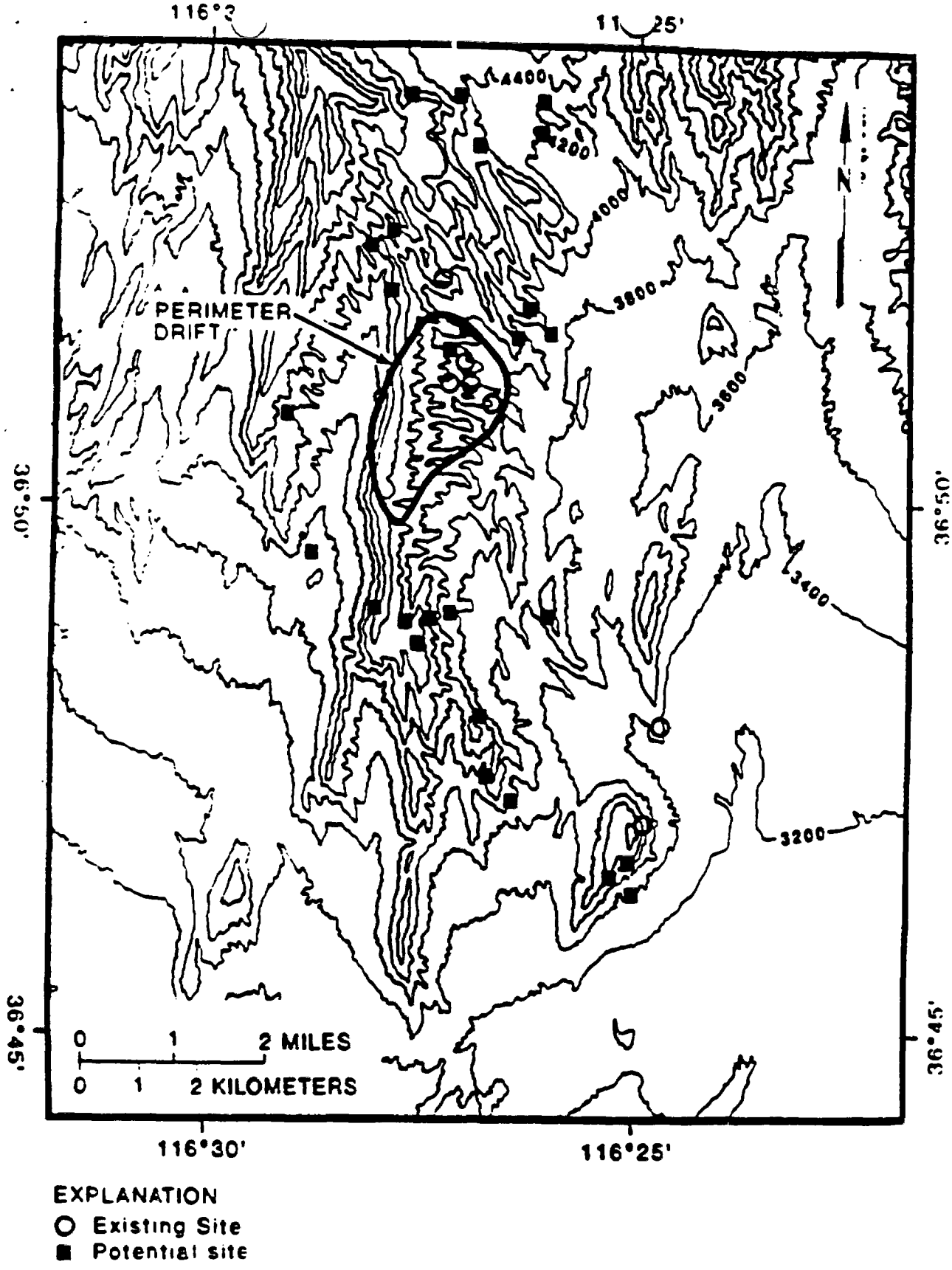

Figure 2.2-1. Location of existing and proposed surface sites for fracture study at Yucca Mountain.

ATTACHMENT 2

May 24, 1990

NOTE TO: Keith McConnell
King Stablein

FROM: William Ford

SUBJECT: PHASE I REVIEW OF ACTIVITY 8.3.1.4.2.2.2 - SURFACE FRACTURE-NETWORK STUDIES; INTERFERENCE CONCERNS (411431 L64333)

In response to the May 17, 1990, request of Keith McConnell and King Stablein to determine if the planned tests constitute either a waste isolation concern or a test interference concern, I have completed a review of pertinent sections of Activity Plan 8.3.1.4.2.2.2. No quantitative calculations were done for this review and the conclusions are based on my professional opinion. It is my professional opinion that the use of water to clear pavement surfaces as described in this study plan will not compromise the repository or result in significant test interference. This conclusion is based on Figure 2.2-1 "Location of existing and proposed surface sites for fracture study at Yucca Mt." This figure (attached) indicates that only 2 proposed sites will be located inside the site boundary and the rest will be widely dispersed; allowing ample area to conduct other types of tests in and around the repository block. It is felt that the amount of water used in these tests will not compromise the repository and that there will be ample areas unaffected by these tests to conduct other experiments.

Should you have any questions I can be reached at 492-0506.

cc: D. Brooks
R. Ballard
J. Linehan
P. Justus
HLGP r/f

HT Sec.

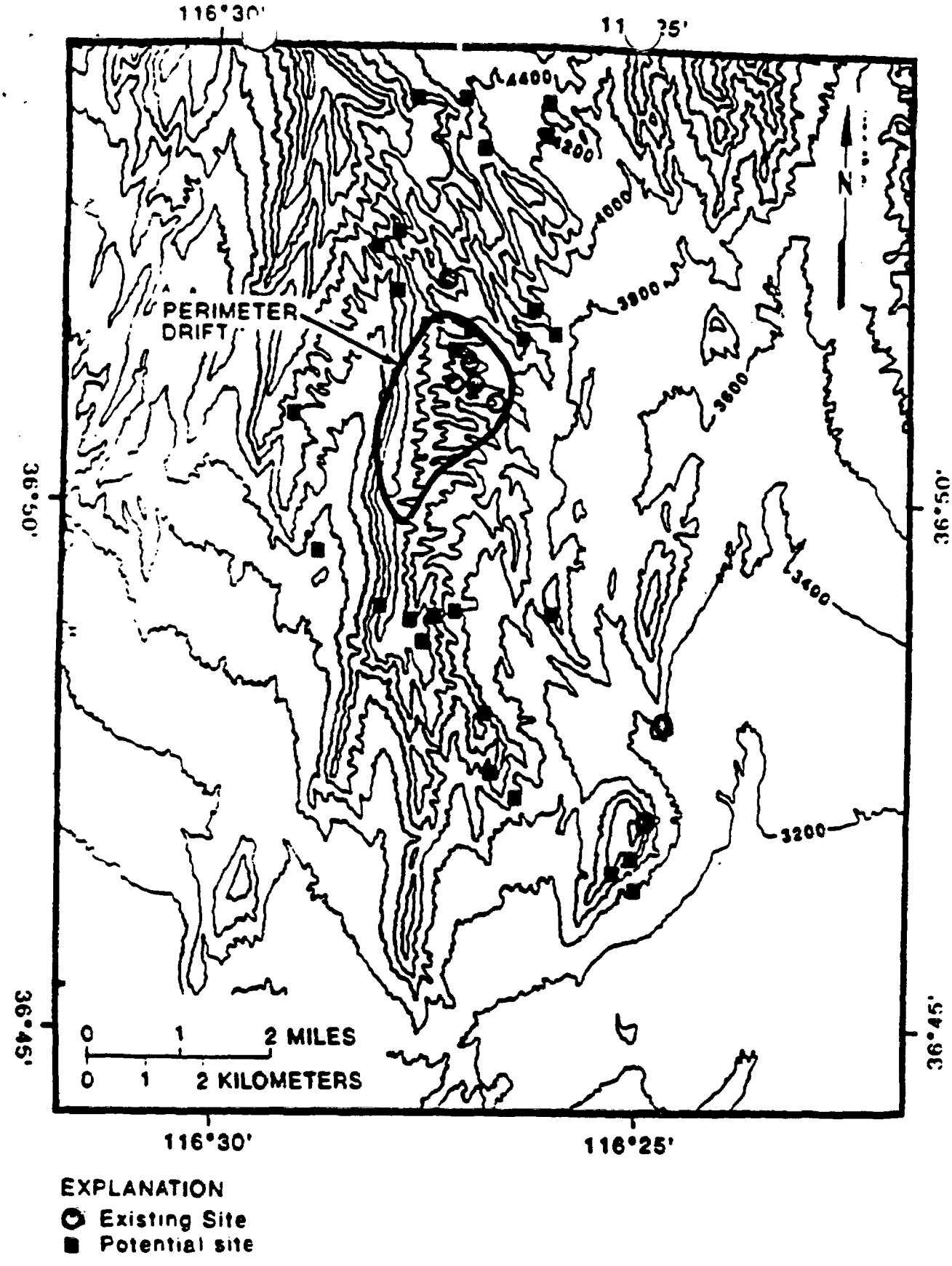

Figure 2.2-1. Location of existing and proposed surface sites for fracture study at Yucca Mountain.