

U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

**NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING**

**SUBJECT: PROBABILISTIC VOLCANIC HAZARD
ANALYSIS (PVHA) AT YUCCA
MOUNTAIN USING EXPERT JUDGMENT**

PRESENTER: KEVIN J. COPPERSMITH

**PRESENTER'S TITLE
AND ORGANIZATION: GEOMATRIX CONSULTANTS
SAN FRANCISCO, CALIFORNIA**

TELEPHONE NUMBER:

**LAS VEGAS, NEVADA
JANUARY 10-11, 1996**

GOALS OF PVHA PROJECT

PURPOSE: To develop an assessment of the probability of disruption of the potential Yucca Mountain repository. The probability estimate should properly incorporate the uncertainties in the assessment.

- Disruption defined as a physical intersection of magma with the potential repository volume.
- Probability defined as an annual probability, the probability over 10,000 years, and over a longer time period.
- Uncertainties incorporated using the judgments of multiple experts; modeling and parameter uncertainties.

APPLICATION: Volcanic risk and performance assessment

FRAMEWORK FOR PVHA

- PVHA is the combination of the *frequency of occurrence* of volcanic activity with the *spatial location* of that activity.
- Numbers of volcanic events in the Yucca Mountain region are low, therefore the future locations and rates of occurrence are uncertain
- To variable extent, hazard methods and parameter values come from interpretations of data in the Yucca Mountain region and data from analogous regions
- Hazard model structure and uncertainty treatment follows that used commonly in PSHA

THE USE OF EXPERT JUDGMENT

In the study of any complex technical problem, expert judgment is used; however, this judgment is generally implicit and undocumented. The PVHA project *explicitly* includes judgments of multiple experts to represent the range of scientific views and *documents* the reasoning on which the judgments are based.

WORKSHOPS AND ACTIVITIES
PVHA Project

<u>ACTIVITY</u>	<u>TOPIC/FOCUS</u>	<u>DATE</u>
Workshop #1	Data Needs	February 1995
Field Trip #1	Crater Flat	March 1995
Workshop #2	Alternative Hazard Models	March 1995
Field Trip #2	Sleeping Butte/Lathrop Wells	April 1995
Workshop #3	Alternative Interpretations	May 1995
Elicitations	Individual Interviews	June-July 1995
Workshop #4	Feedback of Interpretations	December 1995
Draft Report		February 1996

MEMBERS OF EXPERT PANEL, PVHA PROJECT

EXPERT

AFFILIATION

Dr. Richard W. Carlson

Carnegie Institution of Washington

Dr. Bruce M. Crowe

Los Alamos National Laboratory

Dr. Wendell A. Duffield.

U.S. Geological Survey

Dr. Richard V. Fisher

Univ. California, Santa Barbara (Emeritus)

Dr. William R. Hackett

WRH Associates

Dr. Mel A. Kuntz

U.S. Geological Survey

Dr. Alexander R. McBirney

University of Oregon (Emeritus)

Dr. Michael F. Sheridan

State University of New York, Buffalo

Dr. George A. Thompson

Stanford University

Dr. George P.L. Walker

University of Hawaii

**MEMBERS OF METHODOLOGY DEVELOPMENT TEAM
PVHA Project**

MEMBER

Dr. Kevin J. Coppersmith	Geomatrix Consultants, Inc.
Dr. C. Allin Cornell	Stanford University
Dr. Peter A. Morris	Applied Decision Analysis, Inc.
Dr. Steve T. Nelson	Woodward-Clyde Federal Services
Dr. Timothy Sullivan	Department of Energy
Dr. Roseanne C. Perman	Geomatrix Consultants, Inc.
Dr. Richard P. Smith	Idaho National Engineering Laboratory
Dr. J. Carl Stepp	Woodward-Clyde Federal Services
Dr. Robert R. Youngs	Geomatrix Consultants, Inc.

EXPERT ELICITATION PROCESS

PVHA Project

EXPERT SELECTION

- Experts selected using explicit criteria and represent a balanced group
- Range of technical views, expertise, institutional backgrounds
- Many not selected were involved as presenters, field trips, etc.

DATA

- Available, pertinent data bases provided to all experts throughout study

INTERACTION

- Expert interactions encouraged throughout project and facilitated by workshops and field trips
- Technical challenge and defense of interpretations facilitated in workshop setting

PARTICIPANTS AT WORKSHOPS AND FIELD TRIPS

- Specialists provide data and interpretations as presenters at workshops and field trips
- Concerted effort made to present diversity of technical views and to avoid bias

ELICITATION TRAINING

- Training provided for elicitation and uncertainty treatment

EXPERT ELICITATION PROCESS

PVHA Project (Cont'd)

ELICITATION INTERVIEWS

- Elicitations conducted in two-day interview sessions; technical basis for judgments documented in writing

FEED-BACK

- Following elicitations, workshop held and experts given opportunity to discuss interpretations and make changes

AGGREGATION

- Results calculated based on combined expert judgments; individual results also documented

DOCUMENTATION

- Methodology, results, and sensitivity documented in project report; experts document basis for their judgments

PRELIMINARY ASSESSMENTS

SPATIAL MODELS

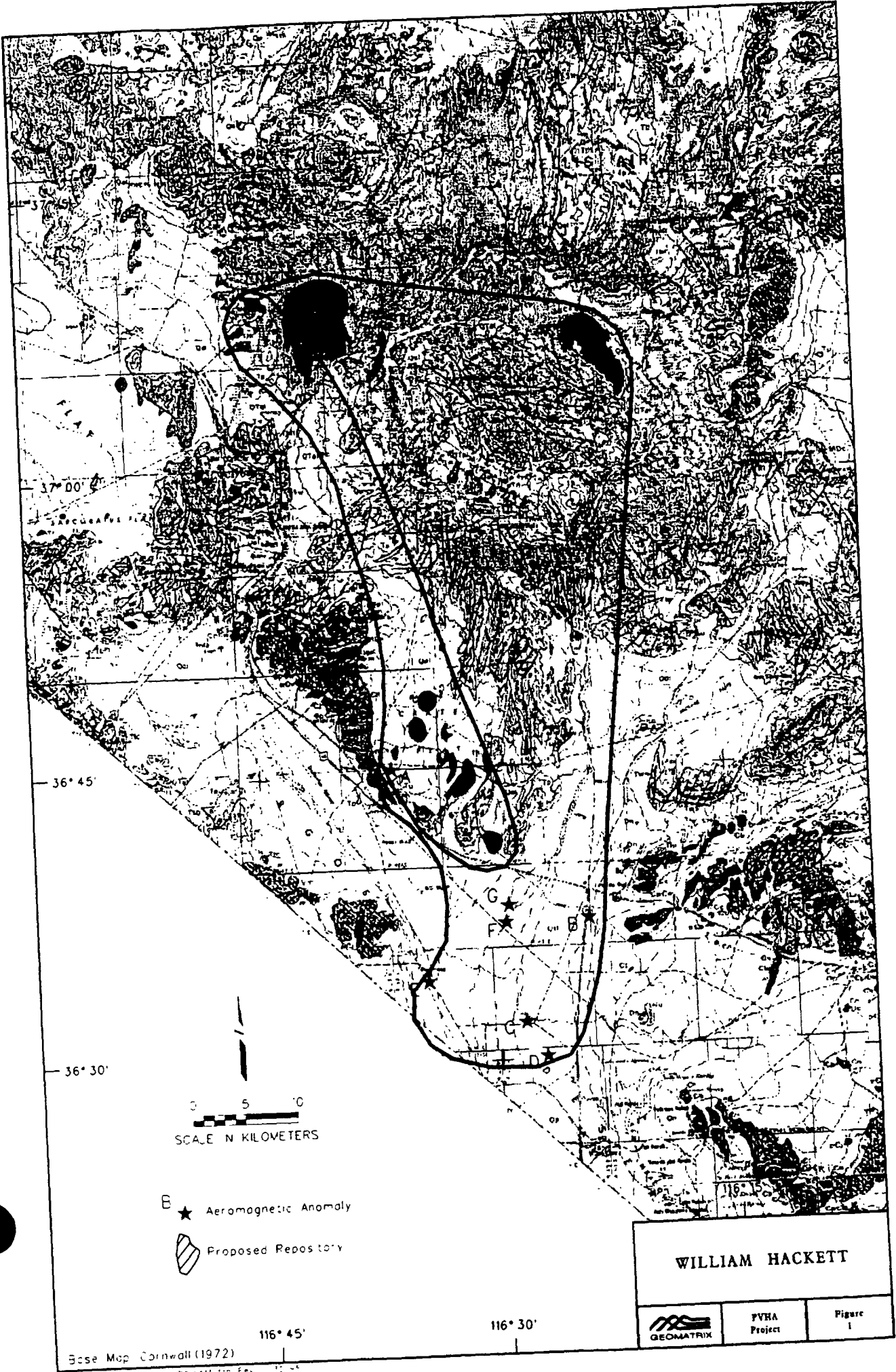
- Homogeneous distribution within interpreted 'source zones'
- Source zones defined from observed volcanic centers, tectonic structures, geochemical affinities
- Parametric spatial distributions using volcanic 'field' analogies
- Spatial smoothing of observed volcanic centers

TEMPORAL MODELS

- Homogeneous Poisson distribution for start times of 1, 5, 10 Ma
- Recurrence rates based on 'event counts', including hidden events
- Non-homogeneous models account for possible waning/waxing of volcanic activity

UNCERTAINTY TREATMENT

- Uncertainties quantified for each expert using logic trees: alternative models and parameters
- Results in probability distribution of annual frequency of intersection of repository across all experts



37° 00'

36° 45'

36° 30'

0 5 10
SCALE IN KILOMETERS

- ★ Aeromagnetic Anomaly
- ▨ Proposed Repository

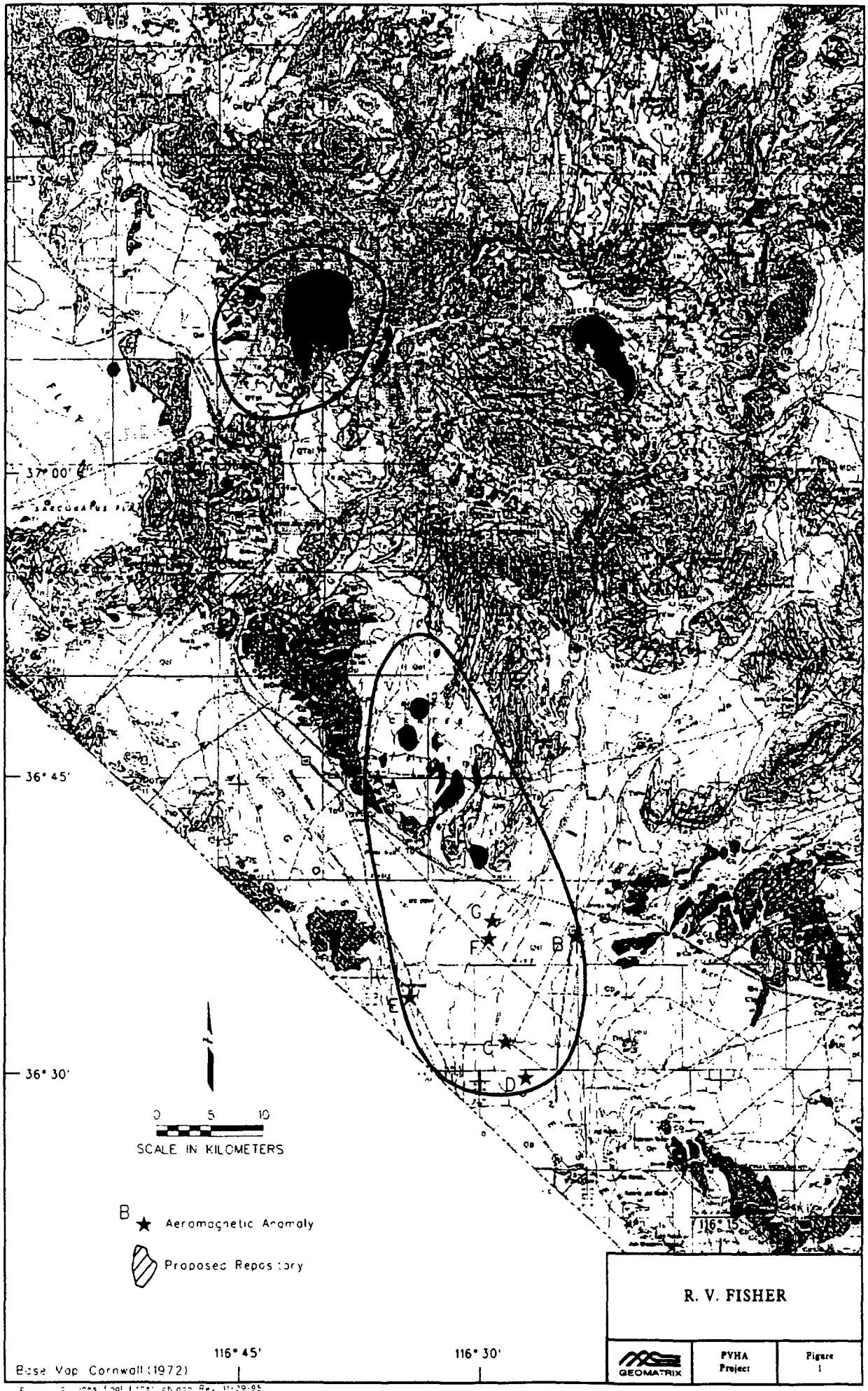
WILLIAM HACKETT

	<p>FVHA Project</p>	<p>Figure 1</p>
--	-------------------------	---------------------

Base Map Cornwall (1972)

116° 45'

116° 30'

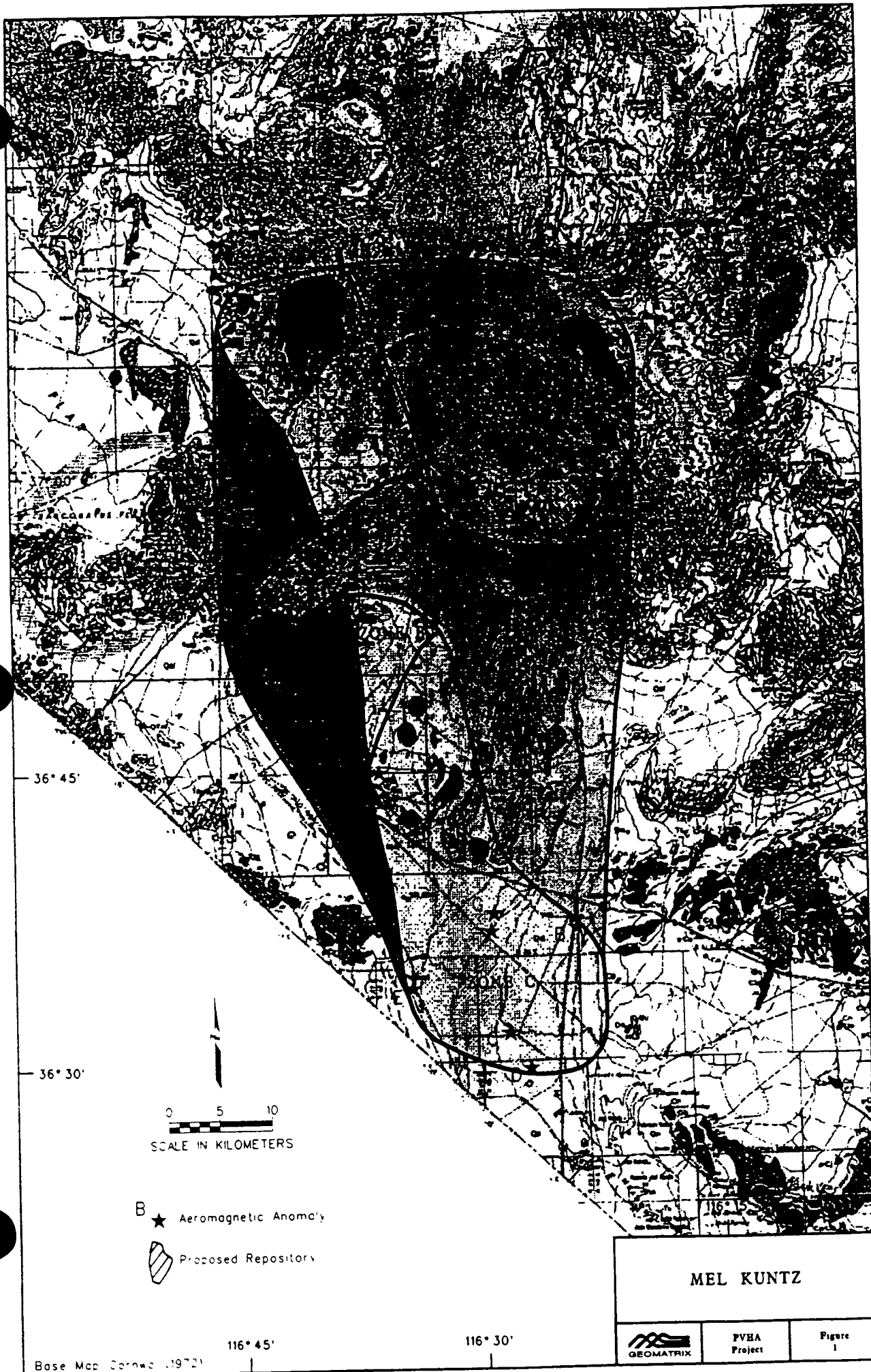


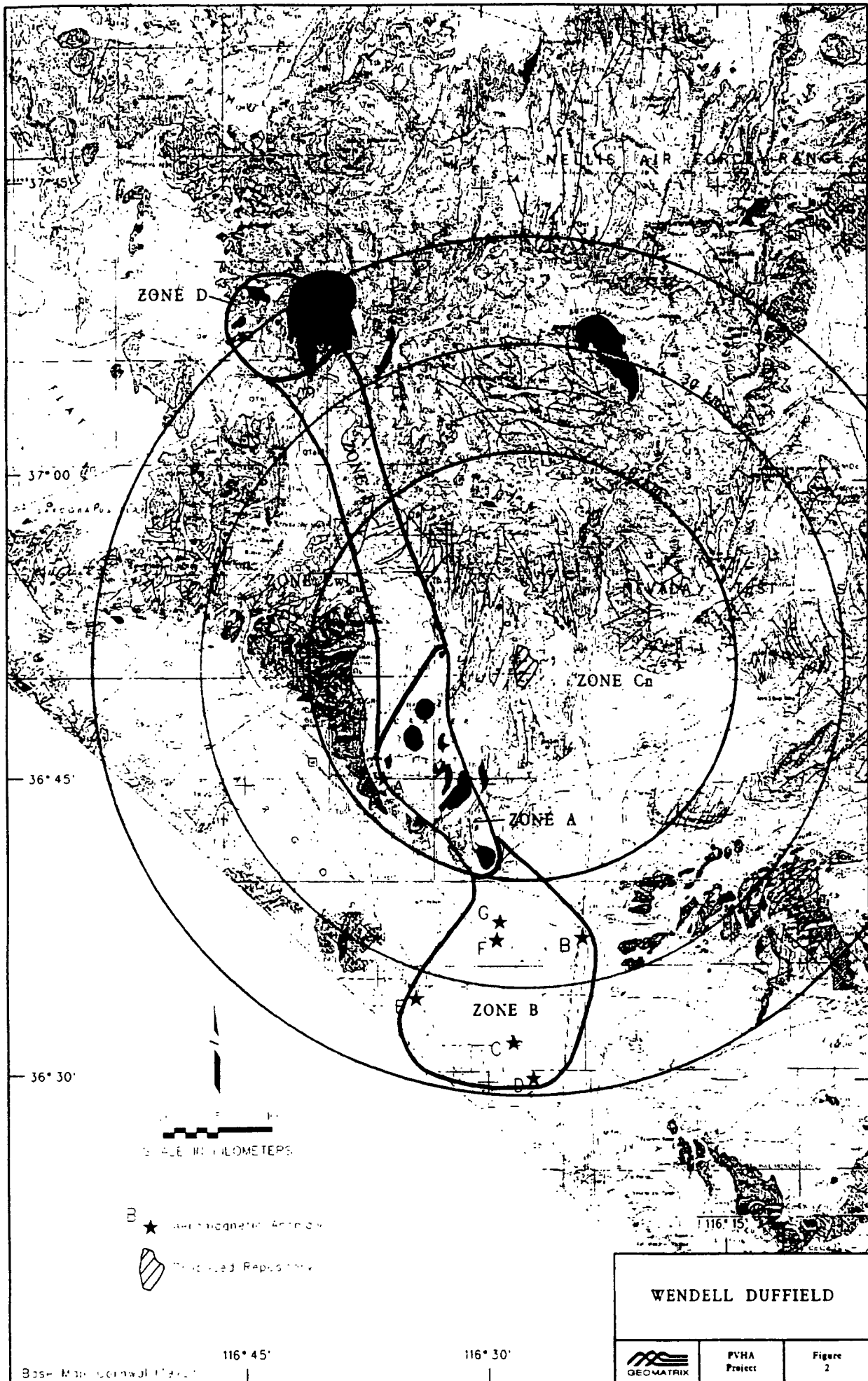
R. V. FISHER

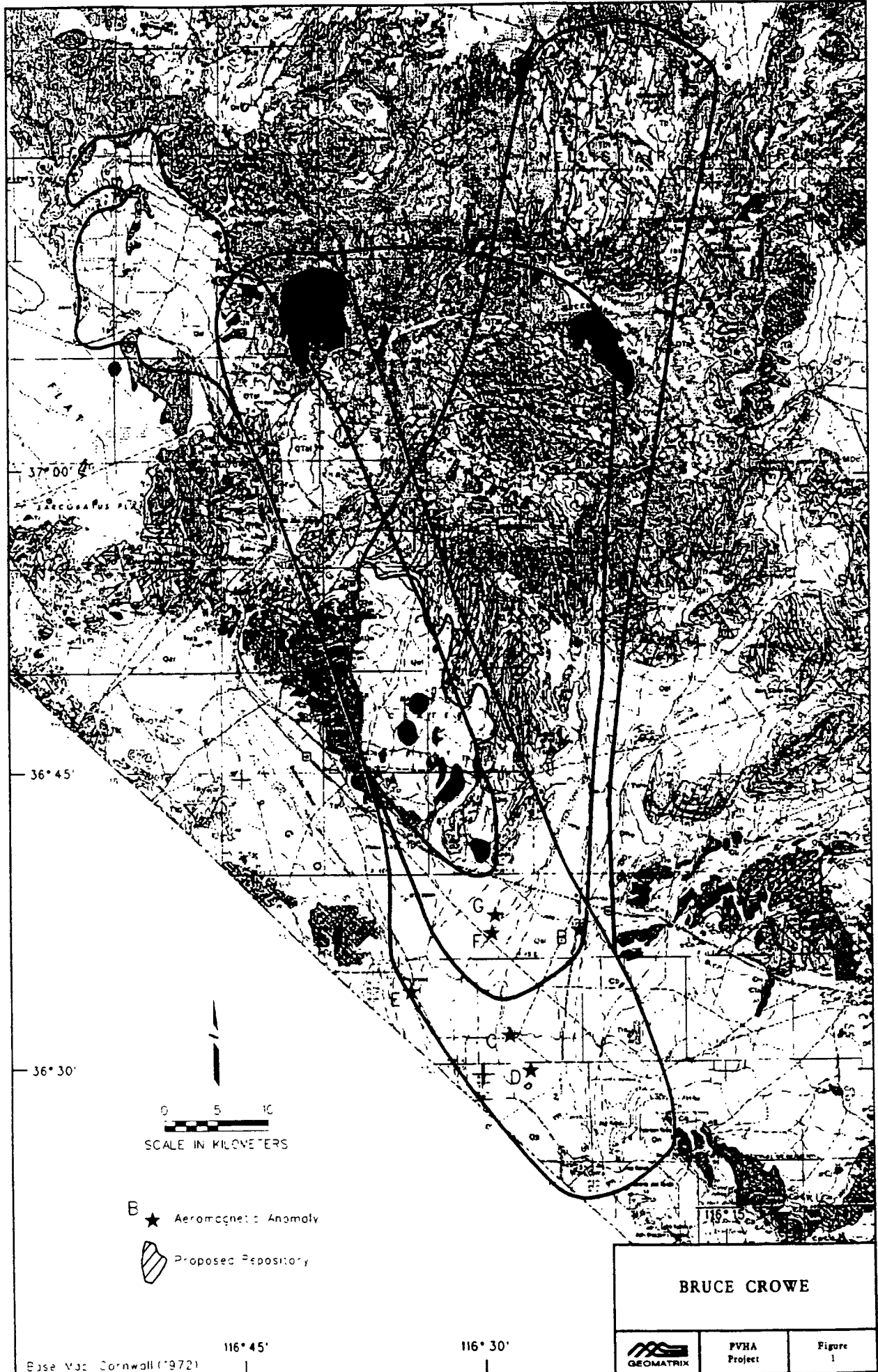


PVHA
Project

Figure
1







BRUCE CROWE

- ★ Aeromagnetic Anomaly
- ▨ Proposed Repository

Base Map: Cornwall (1972)

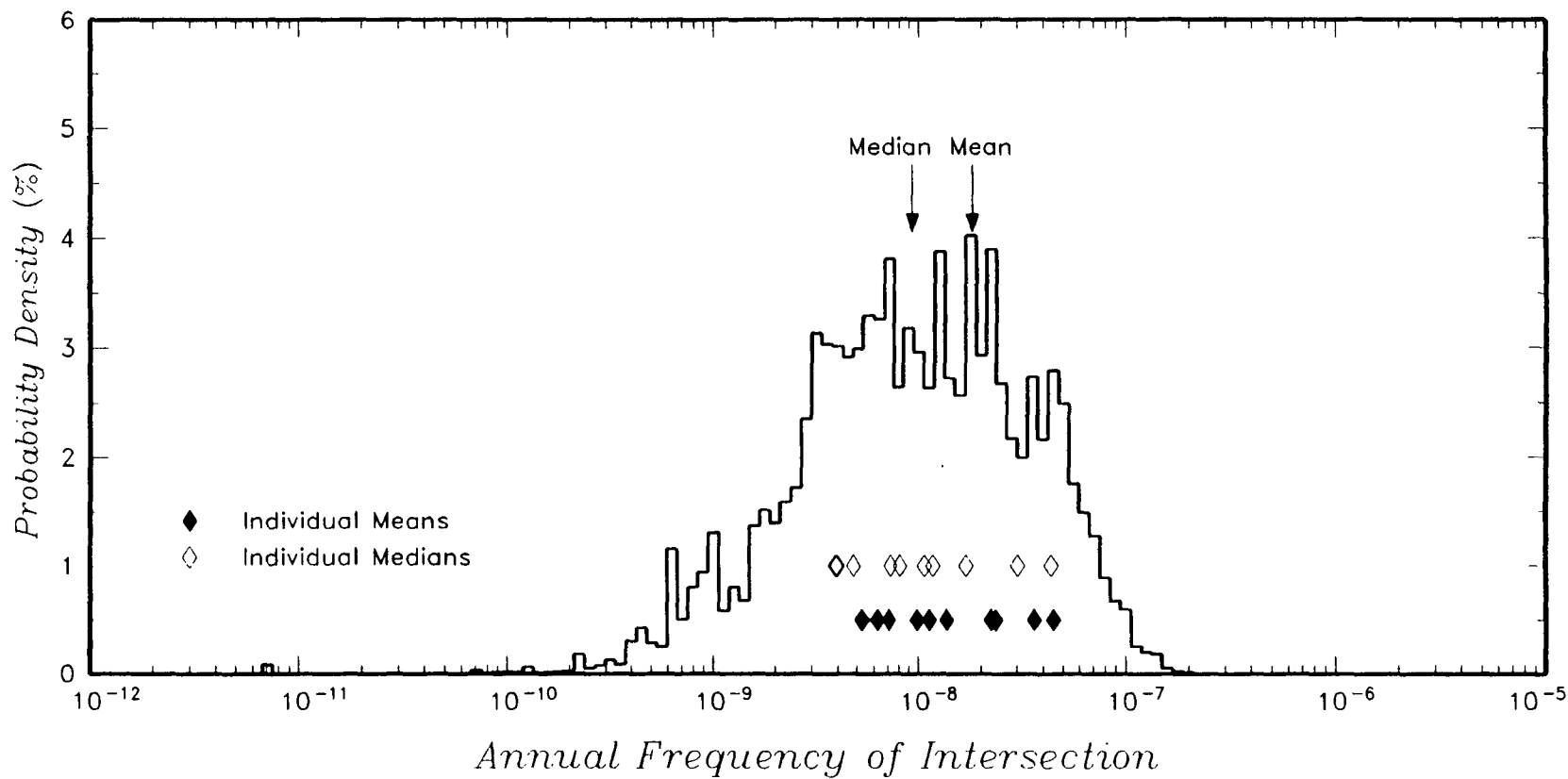
116° 45'

116° 30'



PVHA
Project

Figure
1



IMPORTANT ISSUES

Space

- Site in or out of zone with higher rate of activity
- Length of event vs. distance to more active sources
- Source zones vs. spatial smoothing
- Smoothing distance factor

Time (less important than spatial)

- Events counts
- Homogeneous vs. nonhomogeneous

CONCLUSIONS PVHA PROJECT

- **Complex technical issue addressed using multiple experts**
- **Process designed to minimize bias and promote diversity of views**
- **Multiple facilitated workshops, field trips, interactions to communicate and exchange interpretations**
- **Range of technical views represented through expert panel, presenters, field trip guides, etc.**
- **Elicitations in individual interviews, followed by feed-back workshop and revision**
- **Result incorporates range of scientific views, individual and combined uncertainties**
- **Report documents assessments, and provides defensible probability distribution for risk/performance assessment**