CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES
QUALITY ASSURANCE
SURVEILLANCE REPORT

PROJECT NO.: 20-1402-861 | **REPORT NO.:** 99-04 | **PAGE** 1 **OF** 9

SURVEILLANCE SCOPE: Use of computer software on Southern Crater Flat Fault Geophysical Studies and other work.

REFERENCE DOCUMENTS: None; verbal request from a CNWRA Element Manager for surveillance.

STARTING DATE: February 10, 1999 **ENDING DATE:** March 31, 1999

QA REPRESENTATIVE: Bruce Mabrito

PERSONS CONDUCTING ACTIVITY: Chuck Connor, Pete LaFamina, David Farrell

SATISFACTORY FINDINGS: Discussions were conducted with C. Connor, P. LaFamina, and D. Farrell regarding software that has been written to post-process electrical conductivity and GPS data. This software consists of a single computer code, approximately 200 lines in length, written in standard ANSI C language. C. Connor has put details of this computer code in his scientific notebook (No. 267E, dated April 21, 1998). In addition to the electrical conductivity field work, magnetic field work was conducted during the same surveys. Processing the magnetic data requires several different computer codes, also written in standard ANSI C language and TrueBasic language. C. Connor stated that he has put information about these computer codes in his scientific notebook (No. 115E, dated January 22, 1997).

It has been stated that the above work is not being used to produce a report for the U.S. Nuclear Regulatory Commission and there have been several CNWRA management-level meetings to specifically discuss the products and how they will be used by CNWRA clients. In a meeting March 25, 1999 involving the CNWRA President, Technical Director and two Element Managers, it was decided that these scientific and engineering codes needed to be put under CNWRA TOP-018 Control.

UNSATISFACTORY FINDINGS: None at this time. Inform C. Connor of CNWRA Management decision.

NONCONFORMANCE REPORT NO.: ~~N/A~~ SEE NCR 99-02 dated May 10, 1999. Following CNWRA management meetings on this subject, the referenced NCR was written. BEM 5/10/99

ATTACHMENTS: Pages of electronic scientific notebook 267E by C. Connor, a one page description of Southern Crater Flat Fault Geophysical Studies - Infiltration Along a Fault Zone, and three pages of conductivity difference maps.

RECOMMENDATIONS/ACTIONS: 1. If scientific and engineering software is used to produce a product for a client, Technical Operating Procedure-018 requires that it be identified and controlled; 2. At the present time, no computer code names are associated with the visualization software, but they can be added when the codes are put under TOP-018 control..

APPROVED: [signature]
CENTER DIRECTOR OF QUALITY ASSURANCE

DATE: 4/16/99

DISTRIBUTION:
ORIGINAL - CENTER QA DIRECTOR / QA Records
ORIGINATOR - B. Mabrito
PRINCIPAL INVESTIGATOR - C. Connor
ELEMENT MANAGERS
B. Sagar, H. Garcia, M. Ehnstrom, P. LaFamina, D. Farrell

SCIENTIFIC NOTEBOOK 267E

BY

Charles B. Connor

Southwest Research Institute
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San Antonio, Texas

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Scientific Notebook
Project 20-1402-861

Chuck Connor CC
April 14, 1998

The following C computer code is used to collate the GPS and EM-31 readings. This is necessary in order to plor or contour EM-31 data on a map.

```
Program:
/* Written by: Laura Connor, Programmer
 *                    SWRI - Div09
 * Last Modified: April 6, 1998

* Description:  This code associates location data, gathered with a GPS unit,
and electromagnetic readings.  If the EM31 collects data faster than the GPS
units can acquire locations, the extra location data is interpolated using a
linear interpolation method.

 * History:Written by Laura Connor, April 1998.

 * Inputs:  gps data file
            em data file

 * Data file format (input):

     .pts file generated from gismo software
   (date)       (time)       (easting)  (northing)  (elevation)
   1998/04/05  19:20:28.00  541823.20  4068390.35  903.41

   .g31 file generated from em software
   (tag)  (count) (conductivity) (phase) (time)
   SV10   1.000   3.250          -2.013  19:20:49.95

 * Outputs: data file (with 'utm' appended to input file name

 * Data file format (output):
   easting(lon) northing(lat) elevation(m) conductivity phase
time(HH:MM:SS.SS)

 * Usage:  em <input em file> <input gps file>
 */

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <math.h>

typedef struct {
  double easting;
  double northing;
  double elev;
  double time;
} GPS_READING;

char *getEMline(FILE *em, char *line, int n);
double getseconds(char *time);

int main(char argc, char *argv[])
{
```

```
int ct, len, ret;
char line[256], time[12], date[12];
double cond, phase, em_time;
char outfile[255];
GPS_READING reading[2];
FILE *gps, *em, *out;

if (argc < 3)
{ fprintf(stderr, "Usage: %s <input em file> <input gps file>\n", argv[0]);
   return(0);
}

em = fopen(argv[1], "r");
if (em == NULL)
{ fprintf(stderr, "Unable to open input file: %s\n", argv[1]);
   return(1);
}

gps = fopen(argv[2], "r");
if (gps == NULL)
{ fprintf(stderr, "Unable to open input file: %s\n", argv[2]);
  return(1);
}

len = strlen(argv[1]);
strncpy(outfile, argv[1], len-3);
outfile[len-3] = '\0';
strncat(outfile, "utm", 3);
out = fopen(outfile, "w");
if (out == NULL)
{ fprintf(stderr, "Unable to open output file: %s\n", outfile);
  return(1);
}
printf("Creating output file: %s\n", outfile);

ct = 0;

/* Get first gps reading from file */
ret = fscanf(gps, "%s %s %lf %lf %lf",
             date, time, &reading[0].easting,
             &reading[0].northing, &reading[0].elev);
if ( ret != 5)
{ fprintf(stderr, "Did not get 5 inputs from %s, line: 0 .\n", argv[2]);
  return(1);
}

reading[0].time = getseconds(time);

while (ret = fscanf(gps, "%*s %s %lf %lf %lf",
             time, &reading[1].easting,
             &reading[1].northing, &reading[1].elev), ret != EOF)
{ reading[1].time = getseconds(time);
  if (getEMline(em, line, 256) == NULL) break;
  ret = sscanf(line, "%*s %*s %lf %lf %s", &cond, &phase, time);
  if (ret != 3) break;

  em_time = getseconds(time) + 11.0;
```

```
    if ( abs(em_time - reading[0].time) < abs(em_time - reading[1].time) )
    { fprintf(out, "%.1f, %.1f, %.1f, %.2f, %.3f, %.3f\n",
            reading[0].easting, reading[0].northing, reading[0].elev,
            reading[0].time, cond, phase);
      ct++;
    }
    reading[0].easting = reading[1].easting;
    reading[0].northing = reading[1].northing;
    reading[0].elev = reading[1].elev;
    reading[0].time = reading[1].time;
  }
  fclose(em);
  fclose(gps);
  printf("Done. %d lines processed.\n", ct);
  return(0);
  }

char *getEMline(FILE *em, char *line, int n)
{
     while ( fgets(line, n, em) != NULL )
     if (line[0] == 'S' && line[1] == 'V')
            return line;
  return NULL;
}

double getseconds(char *time)
{
 char hh[3], mm[3];
 double hsec, msec,sec;

 strncpy(hh, &time[0], 2);
 hh[2] = '\0';
 strncpy(mm, &time[3], 2);
 mm[2] = '\0';
 hsec = strtod(hh, NULL) * 3600.0;
 msec = strtod(mm, NULL) * 60.0;
 sec = strtod(&time[6], NULL);
 return hsec + msec + sec;
 /*return atof(hh) * 3600.0 + atof(mm) * 60.0 + atof(&time[6]); */
}
```

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Southern Crater Flat Fault Geophysical Studies - Infiltration Along a Fault Zone

Notes on electrical conductivity surveys and resulting maps.

Terrain conductivity measurements were made using a Geonics EM-31 terrain conductivity meter. Conductivity (quadrature) and phase measurements were collected at one and three second data rates (depending on the survey) and were geo-referenced using a NovAtel real-time kinematic, differential GPS. Position data was also collected at one and three second data rates with accuracies ranging from .02 to 1.0 m CEP. The EM-31 measures changes in conductivity to a depth of 6 m.

Three EM-31 surveys were conducted across the Southern Crater Flat Fault Zone (SCFFZ). Surveys were conducted in April, October and December, 1998. In addition, a magnetic survey was conducted across the SCFFZ in April, 1998. Survey lines were oriented E-W and spaced at 50 m intervals, for a total of 16 lines.

EM-31 data was post-processed using a C++ code written by Laura Connor. This code correlates conductivity and phase readings with position by matching the times recorded in the terrain conductivity meter and the DGPS rover unit. Maps were then made using Geosoft's Oasis Montaj geophysical software package. A minimum curvature gridding algorithm was used to grid the data, with a 15 m grid spacing. The attached maps are color shaded relief maps illuminated from the NE. The conductivity difference map has topographic contours overlain on the conductivity data. The elevation measured by the DGPS rover unit was also gridded at a 15 m grid spacing and is plotted at a 1 m contour interval.

Observations Based on the Difference Map

The conductivity difference map demonstrates that between April and December, 1998 there has been an overall decrease in conductivity in areas of magnetic lows, associated with outcropping or shallow lava flows, which are offset by the SCFF (see figure 4 in Chuck's trip report from the April survey). The areas that demonstrate the maximum increase in conductivity between the two survey periods correlate with two drainage channels. The eastern channel has most likely formed due to vertical offset along the SCFF. The western channel is not as incised. The map demonstrates that groundwater is following topography.

Surveillance

1. David Farrell
2. Pete LaFlamme
3. Chuck Connor

"Post-Processing Code"

→ S/N documentation

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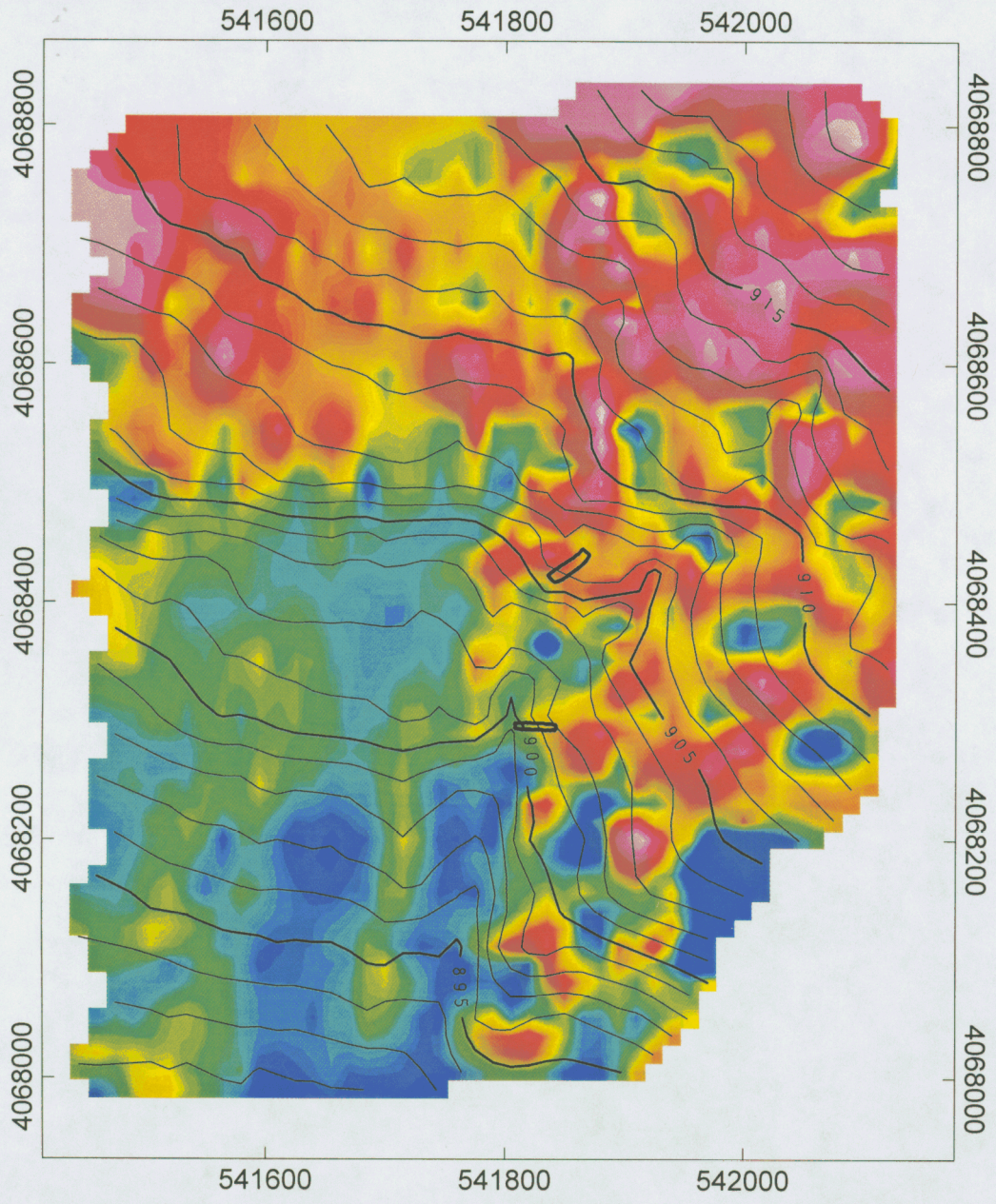

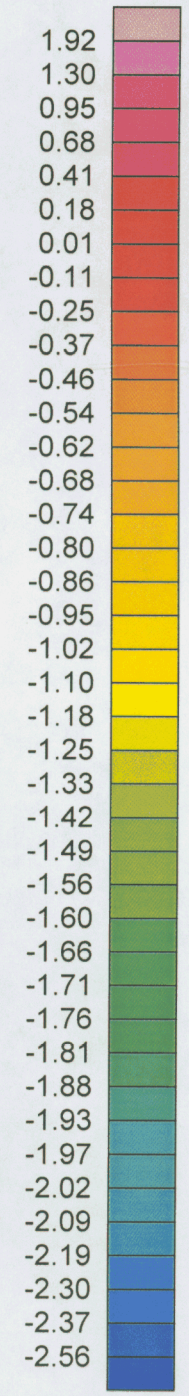

Southern Crater Flat Fault

Conductivity Difference Map

April - December, 1998

Elevation contours - 1m

Boxes indicate the location of trench studies.

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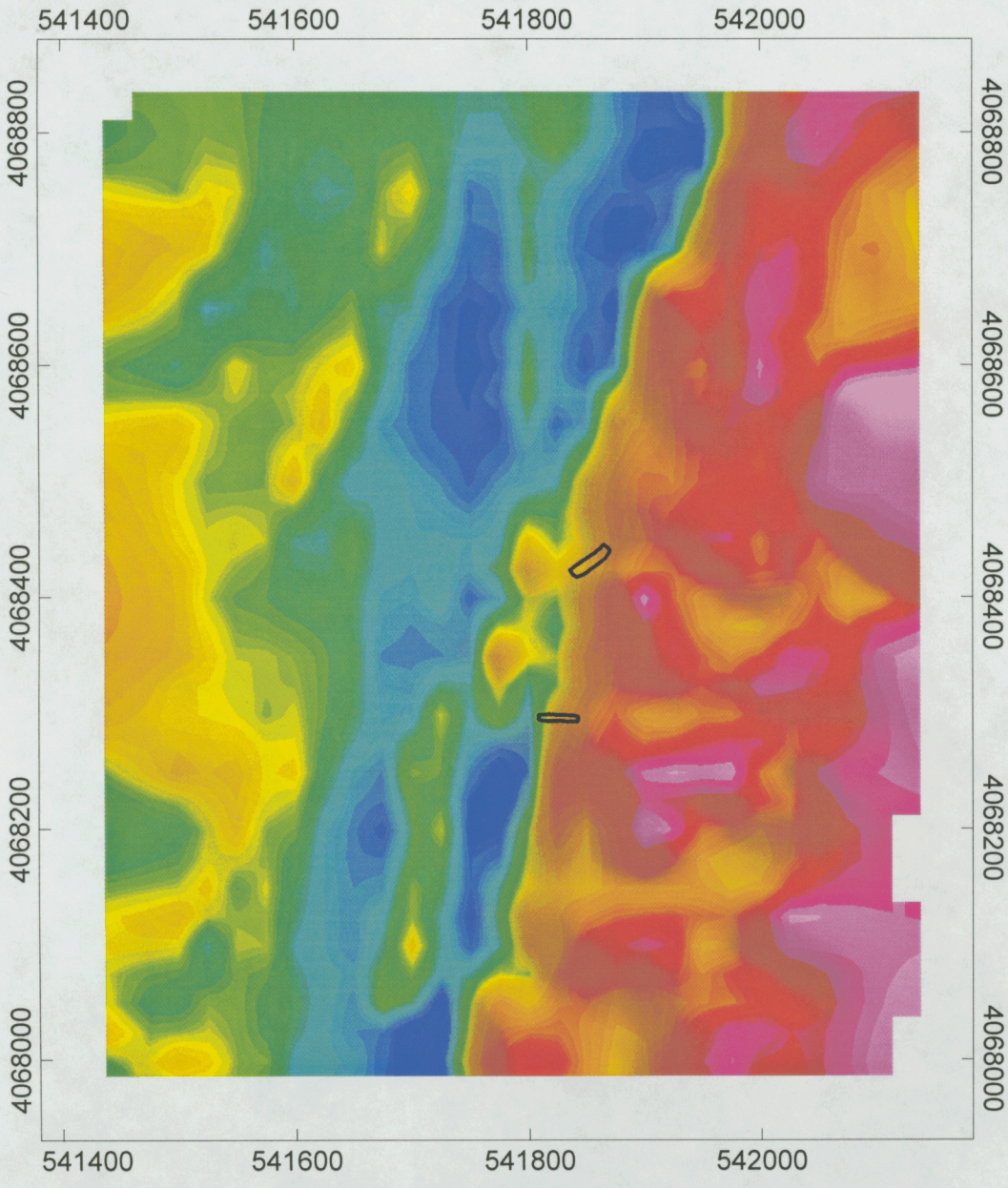
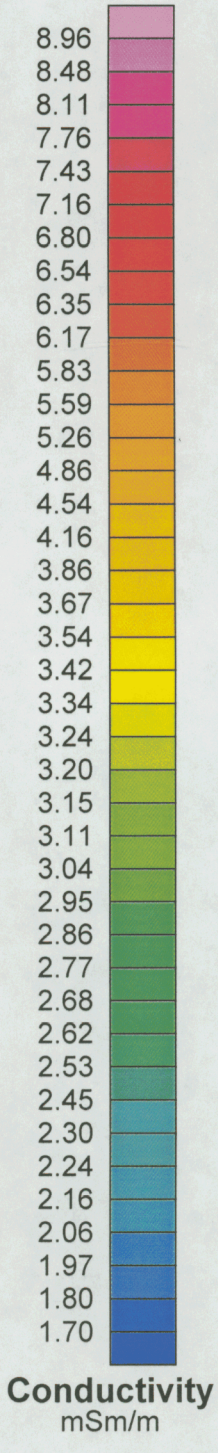
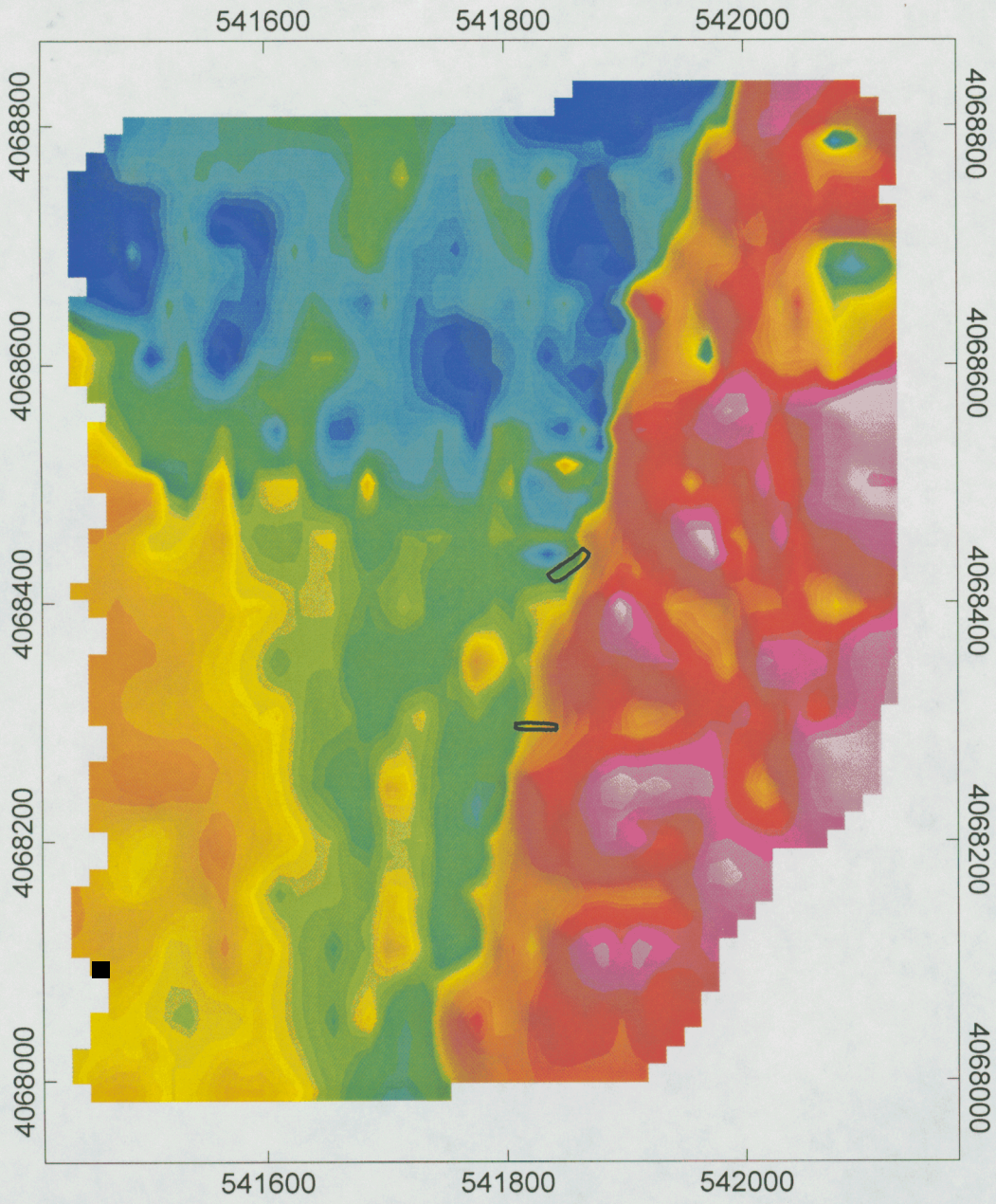


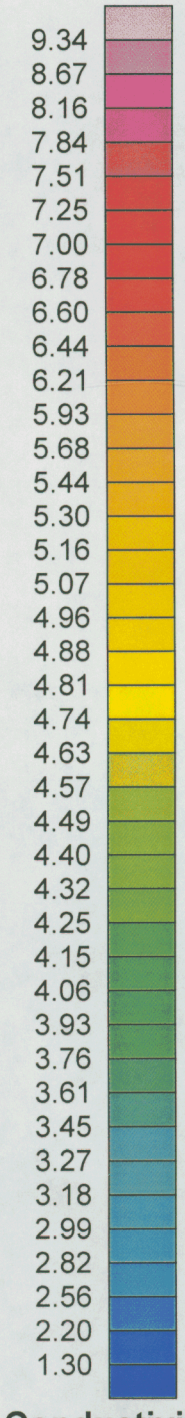


Southern Crater Flat Fault

Conductivity Map

April, 1998





Southern Crater Flat Fault

Conductivity Map

December, 1998