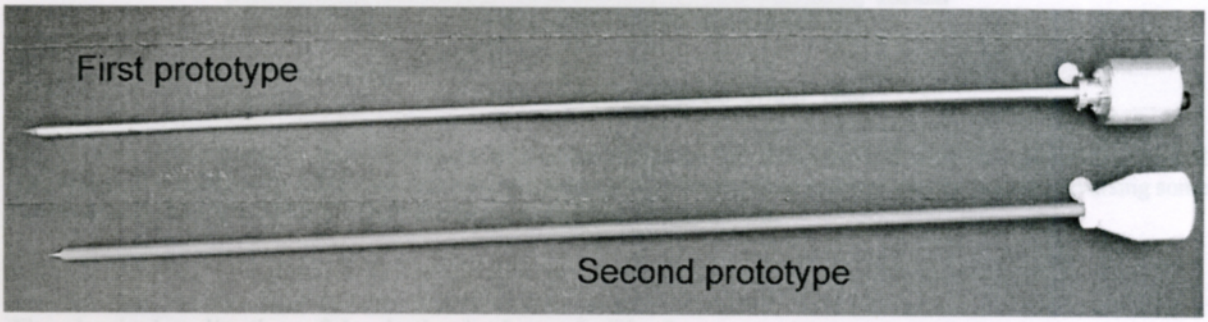
Thermal gradiometer's calibration system

This document describes a calibrator prototype designed for thermal gradiometer's calibration. Thermal gradiometer are devices designed to measure ground vertical thermal gradient in volcanic areas. Thermal gradient is related to heat flow and fluid movement and may be an indicator of some modification in volcanic activity. A thermal gradiometer appears in the following picture:



Calibration system overview

The calibration system for thermal gradiometers performs 2 tasks:

1) Identifies the order of 1-wire sensors inside the gradiometer rod
2) Calculates a correction curve comparing the 1-wire thermometer's output to a well known Pt100 thermometer.

Task 1: identification

1-wire devices are identified by a unique 48-bit address lasered on the chip. The user does not know a-priori the address of the chip purchased, but needs to read it electrically.
Since thermometers are all paralleled inside the rod, the identification by the address is mandatory.

Task 2: calibration

Although their good accuracy (see *Thermal gradiometer: purposes, design and performance* OFR) 1-wire thermometers suffer of poor precision, and this needs to be corrected using a calibration procedure.

Since it is a very difficult task to identify and keep track of a huge amount of thermometers, we decide to assembly all the 1-wire devices without any preliminary identification, and to build a device to calibrate and read the whole gradiometer. Such device must be able to induce a thermal gradient on the whole gradiometer rod, allowing the identification of the thermometers by sorting the read temperatures, and to measure the induced temperature with a precision comparable to the 1-wire thermometer's accuracy. A sketch of the calibration device is shown in fig. 1.

Giuseppe Urbini

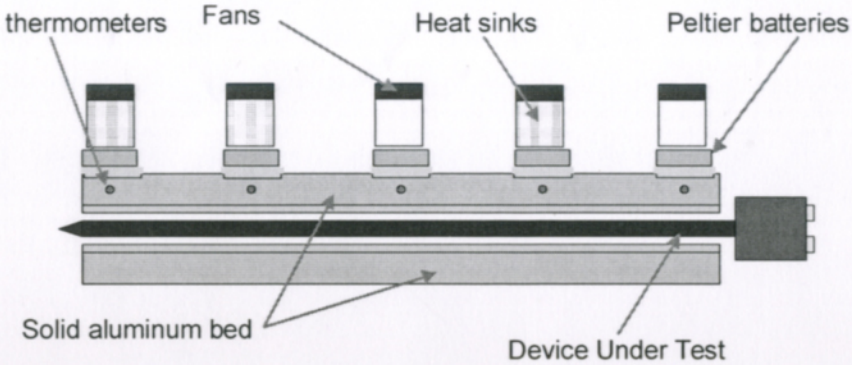
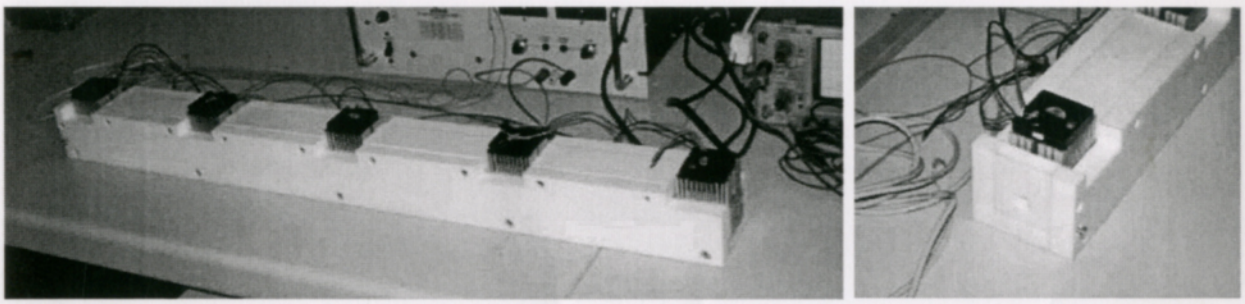


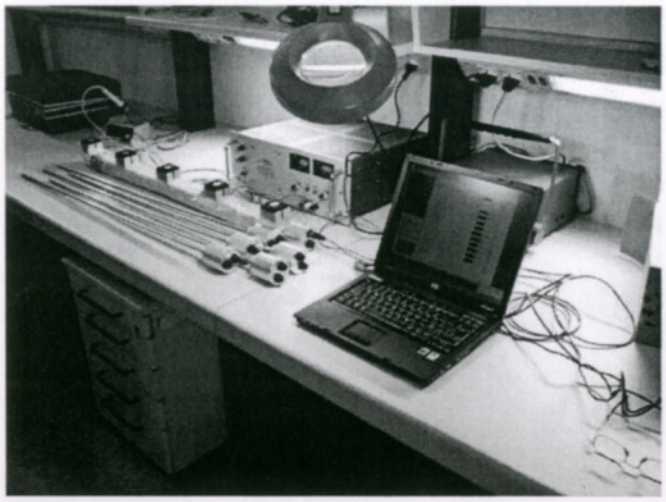
Fig. 1. Five Peltier batteries allow defining a temperature shape on the aluminum bed used for calibration. The bed temperature is monitored by using five calibrated thermometers. A temperature gradient may be induced reversing some Peltier polarity, and is used for the DUT thermometers address identification.

The physical realization of the device is shown in Fig. 2



Fif. 2. The aluminum bed is thermally insulated in a cohibent enclosure. Peltier batteries are thermally connected to the aluminum and to a fanned heat sink. In the photo on the right is visible the hole provided for the rod insertion.

Fig.3 shows some test during the calibrator's debug. On the left, the calibrator set-up on the lab table. The device, without the thermal insulation, was wrapped in a pluriball foil. Peltier batteries and thermometers were controlled by a software, written in Pascal, running on a laptop PC. The main window of this program appears on the right in the picture.



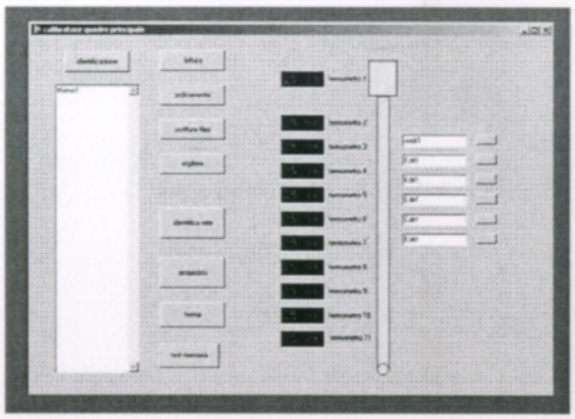


Fig.3 Calibration system debug. On the left, near the power supply, the calibrator under construction, on the right the control PC main screen.

Althoug unpublished this prototype has been presented in Vienna (EGU 2007)

Geophysical Research Abstracts, Vol. 9, 11387, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-11387

Modular thermal gradiometer

G. Romeo, G. Urbini, P. Benedetti, M. Mari

Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy (romeo@ingv.it / Fax Nr: 39 06 5041181)

Direct ground temperature gradient measurement is a nice instrument for heat-flow real-time monitoring. A precise temperature gradient measurement requires a large number of sensors connected to a data logger. In this case sensors installation and wiring is the most difficult task. This paper describes an easy way to implement such an instrument. The instrument allows a simple installation of large amount of gradiometers using a daisy chain architecture. Each gradiometer (a stainless steel tube 1 meter long) contains 11 thermometers, the daisy chain interface and a non-volatile memory filled with thermometer's calibration parameters. The smartphone-based sun-powered data logger offers a nice user interface, local data storage, data transmission and GPS position.

Giuseppe Urbini