

The MERAMEX Project – A Seismological Network in Central Java, Indonesia

Bohm M. (1), Asch G. (1), Fauzi F. (2), Flüh E.R. (3), Brotopuspito K.S. (4), Kopp H. (3), Lühr B.-G. (1), Puspito N.T. (5), Ratdomopurbo A. (6), Rabbel W. (7), Wagner D. (7) and MERAMEX Research Group

- (1) GeoForschungsZentrum Potsdam, Telegrafenberg, Potsdam, Germany,
E-Mail: mirjam@gfz-potsdam.de
- (2) Meteorological and Geophysical Agency, Jakarta, Indonesia
- (3) IFM-GEOMAR, Kiel, Germany
- (4) Gadjah Mada University, Yogyakarta, Indonesia
- (5) Institut Teknologi Bandung, Bandung, Indonesia
- (6) Volcanological Technology Research Center, Yogyakarta, Indonesia
- (7) Christian Albrechts Universität, Kiel, Germany

1. Introduction

The Indonesian volcanic chain is an expression of the ongoing subduction processes along the Sunda island arc. Combined amphibious seismological investigations at 110°E were performed within the project MERAMEX (MERapi AMphibious EXperiment) to study a volcanic system as part of an active continental margin. The active strato-volcano Merapi in Central Java is one of the most active and hazardous volcanoes world-wide. The aim of the project is to acquire deeper comprehension about the relation of subduction zone processes and volcanologic arc processes.

Central Java is part the Sunda subduction zone, where the Indo-Australian plate is being subducted beneath the Eurasian plate with a convergence rate of ~67 mm/yr. Around 110°E a well developed seismicity gap seems to characterise the seismogenic zone along the Sunda subduction zone. Obviously it is accompanied by a separation zone in the oceanic plate, which is manifested in very different crust ages of ~140 Ma east and ~70 Ma west of it, with a corresponding difference in heat flow density. The volcano Merapi is situated in this zone close to its eastern boundary. Furthermore, the seismogenic zone in the extension of the seismic gap under the Java Sea in the north shows an

accumulation of hypocenters in much greater depth. This indicates a correlation between the Merapi and its system of magma ascent and the seismicity gap.

2. Objectives of the Project

A major goal of the MERAMEX project is the determination of a velocity model for the range above the Wadati-Benioff zone by the application of high resolution tomography procedures (V_p , V_p/V_s and Q_p) in combination with the Receiver Function method. The travel time tomography shall provide a three-dimensional image of the lithospheric structure in the area of the Merapi with a resolution of better than 20 km. Important information about the conduits of magma ascent is expected from attenuation tomography. A detailed image of the seismicity distribution of the Wadati-Benioff zone as well as the upper crust shall be derived with exact localization methods. The stress distribution within the downthrusting plate will be acquired from moment tensor inversion.

In addition to the passive tomography experiment active refraction seismic investigations were carried out offshore while the airgun shots were registered onshore too. The combined on- and offshore experiment will allow a

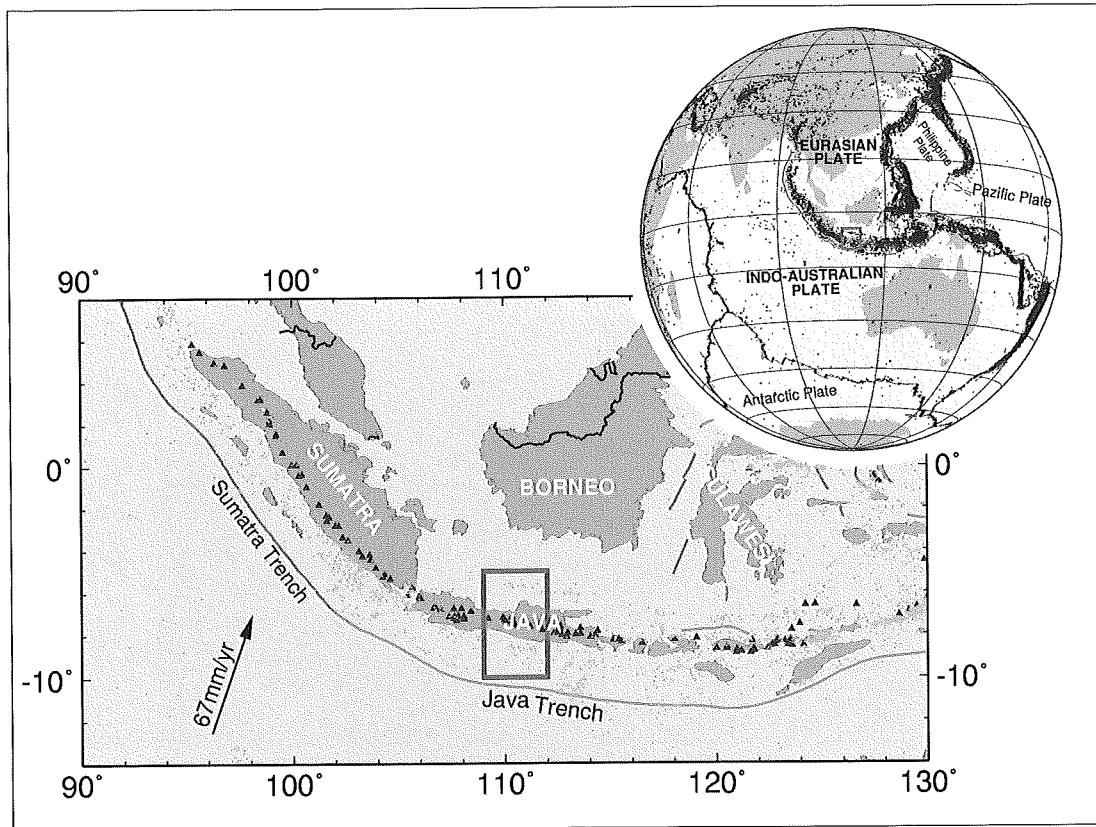


Figure 1: Plate-tectonic setting of the MERAMEX experiment: Central Java is part of the Sunda island arc, which is formed by the subduction of the Indo-Australian plate beneath the Eurasian plate. The seismicity distribution along the Sunda arc is characterized by a gap around 110°E south of Java.

complete correlation of the Wadati-Benioff zone, and will reveal forearc structures up to below Central Java. The derived seismic velocities from the refraction seismic investigations can serve as essential a priori information for the tomography analysis.

3. Present Status and Results

3.1. Seismological Network

The temporary seismological network was in operation for about 150 days from May to October 2004. It consisted of 112 continuously recording seismic stations covering a region of about 150 x 200 km. The stations were equipped with 99 short-period three-component seismometers (Mark L4-3D or Guralp CMG-40T) and Earth data loggers (EDL) recording with a sampling frequency of 100 Hz. The 13 broadband stations were operated with Guralp seismometers (CMG-3T and CMG-

3ESP) and recorders (SAM). The internal clock of the data loggers were regularly checked against Universal Time (UTC) using the GPS satellite signal. The average station spacing was about 20 km. Two of the seismic stations were installed 60 km north of the main network on two small islands belonging to the Karimunjawa island group in the Java Sea just above the accumulation of hypocenters in 600 km depth. The land based network is completed by 9 ocean bottom hydrophones (OBH) and 5 ocean bottom seismometers (OBS) which were deployed offshore at the sea floor operating for a period of 18 weeks. The station spacing of the ocean bottom instruments was about 40-90 km.

3.2. Data Processing

During the experiment a total of 500 Gbyte of seismological data were acquired, which is stored and backed up both on hard disk and DVD. Presently, the compilation of the basis catalogue is in progress. A first triage of the seismological data obtained yields about 5 to 10 local earthquakes and a series of regional and tele-seismic events per day. The local events are

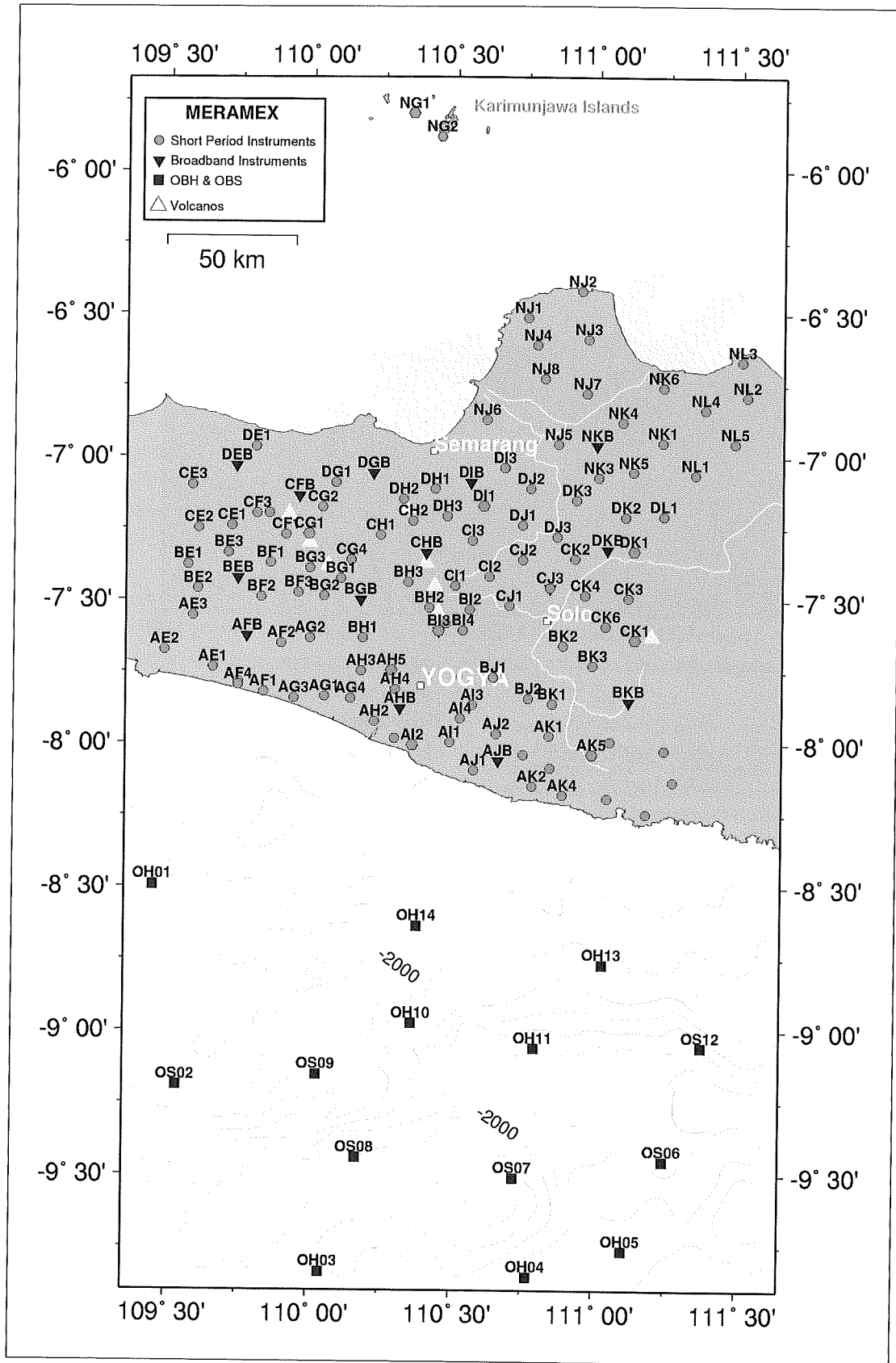


Figure 2: The temporary seismological network: Beside the dense distribution of 112 stations on land, 14 OBH/S were deployed offshore above the seismogenic zone. Additionally, 2 stations were set up on Karimunjawa islands above the accumulation of the ~600 km deep earthquakes.

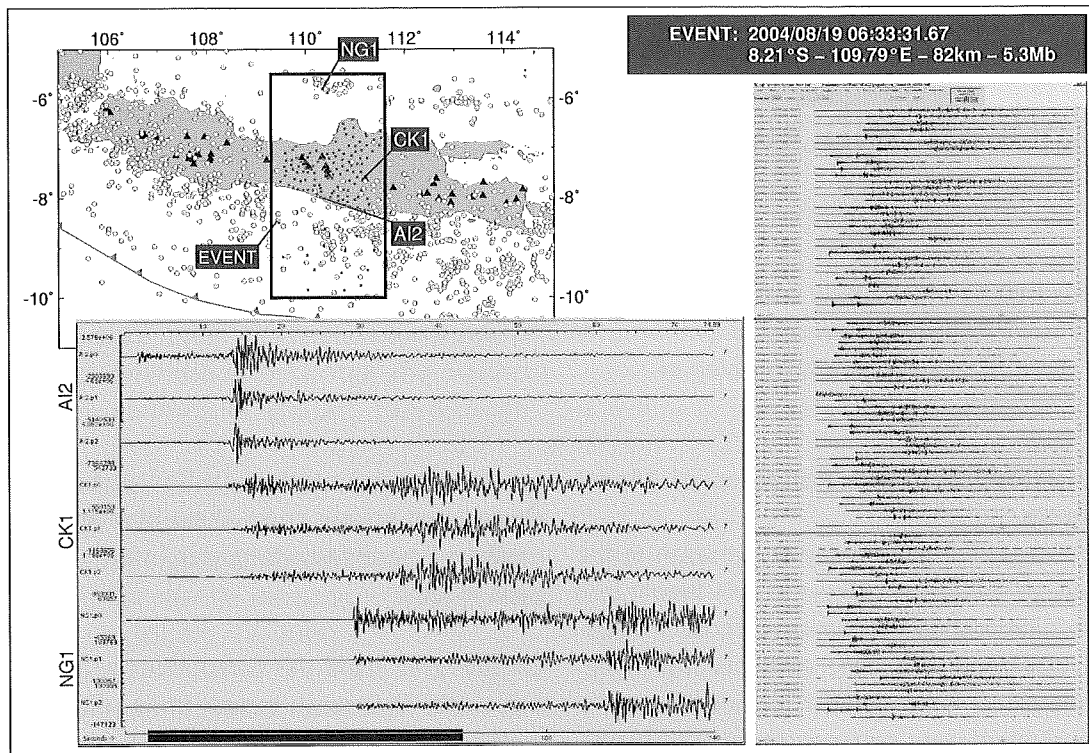


Figure 3: Example of a local earthquake: It took place on August, the 19th with a magnitude (Mb) of 5.3 and could be felt in Yogyakarta and surrounding areas. Seismic signals of the event are observed at all stations.

mainly concentrated in the seismic coupling zone. A very local accumulation of small events takes place in the southeastern part of the network (SE of Yogyakarta) which can be observed only at the AJ-, AK- and BK-stations. Furthermore, two ~600 km deep events located 113.1°E could be recorded on the seismic stations during the operation period. We present the status of the study and first results.

Acknowledgements

This research was funded by the Federal Ministry of Education and Research (BMBF) and the Deutsche Forschungsgemeinschaft (DFG) within the special programme GEOTECHNOLOGIEN. Essential logistical support of the project was provided by the Volcanological Survey of Indonesia (VSI) Bandung, the Volcanological Technology Research Center (BPPTK) Yogyakarta, the Gadjah Mada University (UGM) Yogyakarta and the Meteorological and Geophysical Agency (BMG) Jakarta. We would like to thank alle Indonesian and German colleagues

and students who participated in the fieldwork and made it possible to set up and maintain such an enormous seismological network. Instruments were provided by the Geophysical Instrument Pool Potsdam (GIPP), the Christian Albrecht Universität, Kiel and the IFM-GEO-MAR, Kiel.