

## Final project report

<i>Project ID</i>	2002/11.08
<i>Title</i>	Usò di pathfinder per lo studio di anomalie magnetiche continentali
<i>Principal investigator</i>	Giovanni Romeo
<i>Institution</i>	Istituto Nazionale di Geofisica e Vulcanologia
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<i>Duration</i>	2 years
<i>Assigned funding</i>	36.150,00 Euro

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### Activities and results (max 3000 characters)

The described research had two goals, technological and scientific. The first goal was the realization of a small payload to carry and operate some geomagnetic instrument up to the stratosphere. The second was to take measurements of the geomagnetic field at continental scale. The design involved : power supply system, telemetry, GPS localization, ballast and release system and the magnetometers. The power system used solar cells and rechargeable batteries so increasing the experiment life to the balloon life. The telemetry was designed around an Iridium terminal, interfacing it to control the payload, issue commands (like ballast or balloon release, system or peripheral reset etc.) and download housekeeping and scientific data. Magnetometers were ringcore flux-gate made by INGV. All the system was housed in an especially built pressurized container, thought to keep the instruments in comfortable conditions in continuous direct sunshine, in the stratosphere. We called this payload PEGASO, Polar Explorer for Geomagnetism And other Scientific Observations.

The mission's ground control required some software for communication with the balloon, alarm handling (including SMS), web page upgrade, data storing and retrieval. This light payload (10 Kg, including ballast) and parts of it have been tested in several successful missions in the northern hemisphere, used to get technical information to improve the design. PEGASO A (2004) was launched from Longyearbyen. The main goal was to check the system design, telemetry data and position. This also allowed investigation of the circumpolar trajectory. The flight lasted 40 days before termination and showed a westward path. There was no magnetometer on this payload.

PEGASO B&C were launched in 2005. PEGASO B was equipped with a 3-axis fluxgate magnetometer, and traveled 9966 km before termination (25 days). PEGASO C traveled 6317 km, 13 days. There was no magnetometer on this payload. PEGASO D (2006) was launched from MZS Station (Terra Nova, Antarctica). Some logistic and technical problems delayed the launch, which occurred too late for a circular trajectory. Moreover some malfunction inside the telemetry stopped the data transmission: during most part of the flight, the system was just able to execute remote commands.

PEGASO E (2006) was launched from Longyearbyen again, at the right time to obtain a perfect circumpolar trajectory, and was terminated over Greenland, in a place suitable for recovery. PEGASO E hosted also RDR/BXR a joint Norwegian-Italian student experiment to study highenergy particle showers and associated bremsstrahlung radiation in the polar atmosphere.

Project results are the system design and prototyping and the data records of travelled northern paths. Unfortunately there is a lack of geomagnetic results because of the electronic failure in Antarctica.

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### Products

#### A – papers in scientific magazines

1. PEGASO: An ultra light long duration stratospheric payload for polar regions flights. A. Iarocci, P. Benedetti, F. Caprara, A. Cardillo, F. Di Felice, G. Di Stefano, P. Drakøy, R. Ibba, M. Mari, S. Masi, I. Musso, P. Palangio, S. Peterzen, G. Romeo, G. Spinelli, D. Spoto, G. Urbini. J. Adv. SpaceRes. (2007), doi:10.1016/j.asr.2007.05.079

## Programma Nazionale di Ricerche in Antartide (PNRA)

2. G. Romeo. Drive Pyrotechnic Igniters From a Microprocessor Port, Electronic Design, 12 08 2004 n. 57, pp 67-68

### B – book chapters

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### C - proceedings of international conferences

1. Romeo, GR; Di Stefano GDS; Di Felice, FDF; Masi, SM; Cardillo, AC; Musso, IM; Ibba, RI; Palangio, PP; Caprara, FC; Peterzen, SP; Pegaso Group. Pegaso Long duration Balloons from polar regions. COSPAR presentation July 2006.
2. Steven E. Peterzen, Roberto Ibba, Gunnar Jan Olsen, Petter Dragoy, Silvia Masi, Gianni Romeo, Giuseppe diStefano, Andrea Cardillo, Ivano Musso. FIRST CIRCUMPOLAR TRAJECTORY ULTRALIGHT TO HEAVY LONG DURATION BALLOON DEVELOPMENT FROM SVALBARD, NORWAY. Proceedings of the 18th ESA Symposium on European Rocket and Balloon Programmes and Related Research (ESA SP-647, November 2007) pp 97-104

### D – proceedings of national meetings and conferences

1. A Cardillo, O. Casentino, F. Di Felice, G. Di Stefano, S. Masi, P. Palangio, S Peterzen, G. Romeo, Q. Taccetti. Trailblazer and PEGASO: exploring Polar Regions using small stratospheric balloons. Meeting Nazionale sulle tecnologie del PNRA, 14-15 mar. 2003, poster and talk
2. Francesca Caprara, Andrea Cardillo, Paolo Benedetti, Orazio Cosentino, Giuseppe Di Stefano, Fabio di Felice, Massimo Mari, Giuditta Marinaro, Silvia Masi, Paolo Palangio, Steven Peterzen, Giovanni Romeo, Quintilio Taccetti. Geomagnetic exploration of polar areas using small balloons: PEGASO Trailblazer. Workshop 'New Technologies in Geophysics, Geomechanics and Volcanology', Naples September 18-20 2003. Poster and talk.
3. S. Peterzen, G. Romeo, G. Di Stefano, S.Masi, I.Musso, P.Dracoy, F. Di Felice, R. Ibba, P.Palangio, F. Caprara, A. Cardillo, D. Spoto, A. Memmo, M. Mari, A. Iarocci, G. Urbini, P.Benedetti, G. Spinelli. Pegaso, Long duration Balloons from North Pole. XVIII CONGRESSO NAZIONALE AIDAA, 19-22 settembre 2005 VOLTERRA (PI). talk and proceedings article.

### E – thematic maps

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### F – patents, prototypes and data bases

1. Complete mechanic, electrical and software design of the flying system and the ground station.
2. Instrument records from the travelled paths. Five prototypes have been built and launched. Parts of a sixth prototype are assembled and available in the INGV laboratory

### G – exhibits, organization of conferences, editing and similar

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### H - formation (PhD thesis, research fellowships, etc.)

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## Research units

### One research unit:

Quintilio Taccetti	Elettronica, calcolo	I.N.G.V.
Paolo Palangio	Strumentazione, geomagnetismo	I.N.G.V.
Giuseppe Di Stefano	Elettronica	I.N.G.V.
Silvia Masi	Elettronica e lancio	Univ. La Sapienza
Orazio Cosentino	Coordinamento ASI	ASI
Andrea Cardillo	Calcolo traiettorie	ASI
Steven Peterzen	Meccanica e lancio	NSBF (USA), ASI
Fabio di Felice	Elettronica, calcolo	I.N.G.V.

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**Date:** Thursday, 02 April 2009

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## Notes