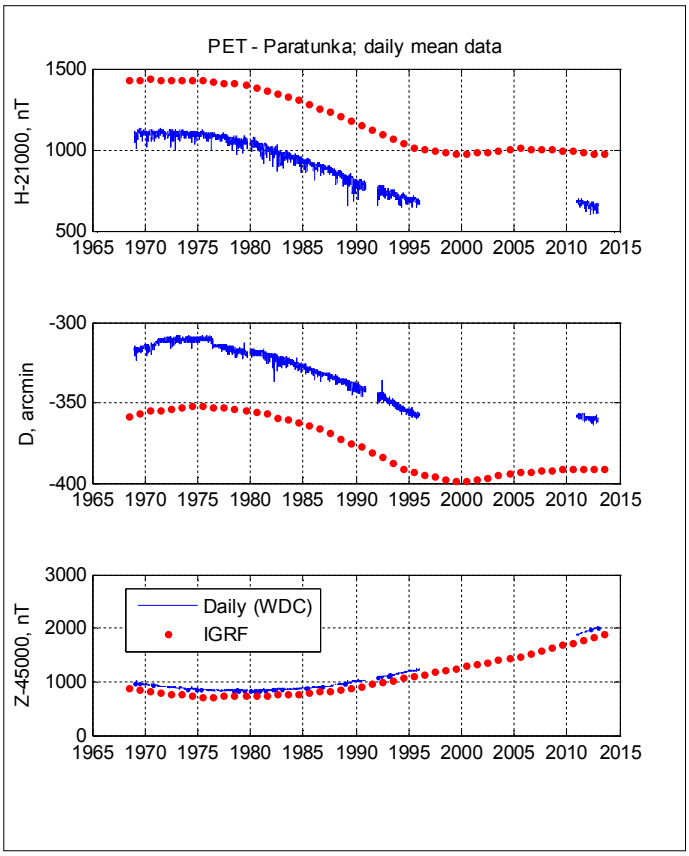
The creation of the database of images of old analogue magnetograms of Geophysical Observatory "Paratunka", Kamchatka, Russia, 1967-2006

VarSITI / SCOSTEP Project
Final Report – 2014

1. INTRODUCTION

Magnetic field variations show the processes in the Sun-Earth system. The historical pre-digital data are very important for the investigation of old events. These data are contained in analogue magnetograms obtained at the observatories during the last century. In most cases the hourly data were obtained from analog magnetograms according to standard IAGA. However, these photorecords can provide the magnetic data with high temporal resolution up to one minute.

Regular magnetic measurements are carried out at Paratunka Geophysical Observatory of the Institute of Cosmophysical Research and Radio Wave Propagation of the Far-Eastern Branch of Russian Academy of Science (IKIR FEB RAS, http://www.ikir.ru/en/About/index.html), Kamchatka, Russia, since 1967. Average monthly values, calculated on the basis of observatory hour data from WDC for Geomagnetism (Edinburgh), are shown in Fig. 1. The same figure illustrates annual values according to IGRF11 model.



An archive of analogue magnetograms was created. However, it is inaccessible to the world scientific community and inconvenient for digital processing. There is also the possibility of losses due to the presence of only a single copy. The usual solution of these problems is to obtain the graphic images of magnetograms. The examples of this approach can be found at WDC

http://wdc.kugi.kyoto-u.ac.jp/film/index.html
http://www.wdcb.ru/stp/data/Images_of_Magnetograms/index.ru.html

Figure 1. Variations of magnetic field at PET observatory (1969-2013, daily values, WDC for Geomagnetism, Edinburgh), obtained from analogue magnetograms (before 1996, IAGA Standards) and INTERMAGNET data (since 2010) and data from IGRF11 model.

2. GOALS

The goal of this project is to create the database of the images of analogue magnetograms and complementary information (baseline values and scale coefficients) for Paratunka Geophysical Observatory (IAGA code is PET) for 1967-2006 and to transfer the database to the WDC (Moscow and Kyoto). The database of old analogue magnetogram images will be available to the international scientific community and the digital processing and will solve the problem of long-term storage, provide security and data integrity.

3. DESCRIPTION OF ANALOGUE MAGNETOGRAMS

Analogue magnetograms of Paratunka Observatory are daily records of magnetic field variations on photopaper with the width of 28.5 cm and the length of about of 50 cm. The Bobrov's quartz sensors (IZMIRAN) are used as variometers. Variation tracks and a baseline are displayed on the magnetogram for each recorded component. Also, a magnetogram contains:

- the title with the date of record beginning and end in UT and the name of the observatory (in Russian);
- time values on hour marks in UT;
- the names of tracks with indication of the direction of field increase and names of baselines for every component;
- temperature in the variation house;
- baseline values, scales and temperature coefficients (periodically).

The primary archive includes the magnetograms of ordinary and storm systems, which are marked as "I" and "II", accordingly. The storm system has smaller sensitivity and is used for estimation of variations during magnetic storms, when a track is moved outside the photopaper or disappears due to high speed of light spot. In addition, the storm system is used as a backup system during the failure of ordinary system (hardware or photopaper defect).

On the magnetograms of ordinary system the variations of magnetic components D, H, Z are recorded. The storm system also records the variations of total field F. The resolution of records of ordinary system is about 2.1-2.5 nT/mm for H, 0.20-0.22 ′/mm for D and 1.0-3.5 nT/mm for Z.

4. IMAGES OF MAGNETOGRAMS

The magnetograms were scanned using an ordinary scanner with A4 format. Three images were obtained from every standard magnetogram (beginning, middle, end), with about three-hour overlapping. If a magnetogram was short, only one or two images were obtained. Every image includes a scale with the length of 50 mm. An example of magnetogram images for January 31 – February 01, 1987 is presented in Fig.2.

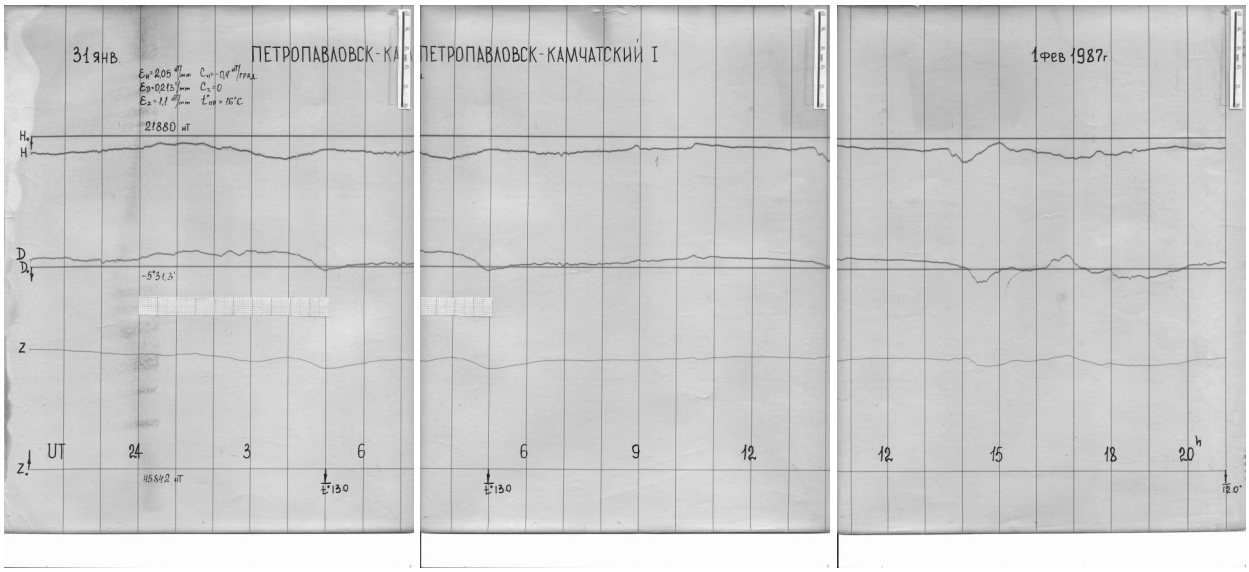


Figure 2. An example of images, which was obtained for a magnetogram of Paratunka Observatory for Jan 31 – Feb 01, 1987.

Normally every image is a TIFF format file with the resolution of 300×300 dpi and of gray color (8 bits per pixel), the size of a file is about of 9 Mb. For the magnetograms since 1998 the images of magnetogram pieces were joined into a single daily image and saved as a JPEG file with the resolution of 200×200 or 300×300 dpi.

The names of image files are presented in the format MYYYYMMDD-yyyymmdd_N_SS, where YYYYMMDD and yyyymmdd are the year, month and day of the record beginning and the end of a magnetogram, N is the number of a piece, SS is the code of the system (I – ordinary, II – storm). Similar names are also used for jointed images. The base of images is structured according to the magnetogram date: directories were sorted by years and months.

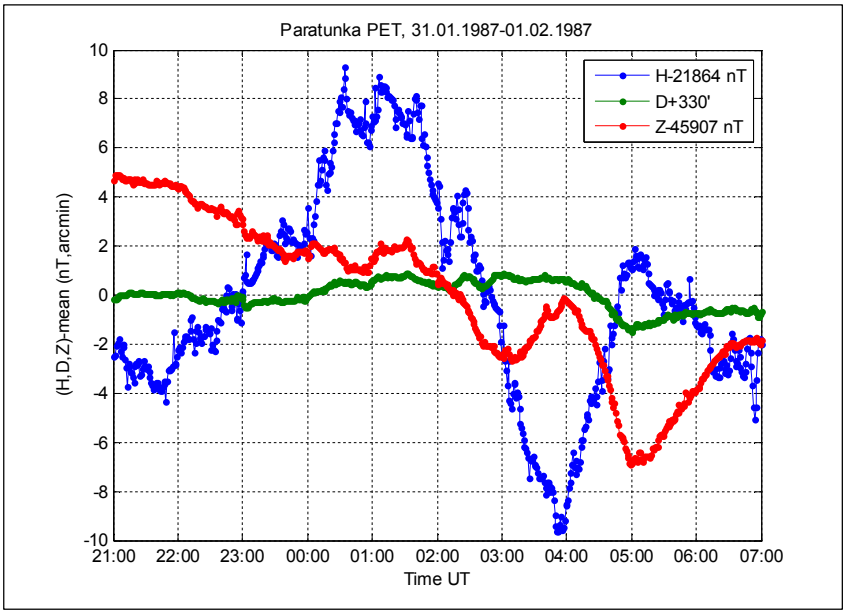
Also, a special information file was prepared, which include additional parameters: baseline values, scale and temperature coefficients and dates when these parameters were adopted.

5. RESULTS

For the most part, the scanning process was performed from April to August, 2014. Jointed images were prepared in advance. Complete check of images with re-scanning if necessary and DVD recording were carried out in September, 2014. Total number of images in the database is 41103, the total size of the database is about of 305 Gb. The project was executed by a technician, an engineer, a magnetologist and a project leader. Three external hard disks, a printer, 125 DVD-R disks and some office supplies were purchased.

The base of images of magnetograms for Paratunka Observatory recorded on DVDs was sent to the WDC on Solar-Terrestrial Physics (Moscow, Russia) and to the WDC for Geomagnetism (Kyoto, Japan).

The obtained images are suitable for the following digitization and for obtaining of magnetic variation with the rate grater than one hour (IAGA Standard). For example, in Fig.3 the minute values of H,D,Z variations are presented. These values were obtained for the first image of the magnetogram in Fig. 2 using special routine WFD for digitization of magnetograms (Waveform digitizer, v.2.1 b4, A.Burtsev, M.Zhizhin, 2003).



This work was supported by SPeCIMEN/VarSITI grant.

Figure 3. An example of digitization of the magnetogram image presented in Fig. 2: minute values of full H,D,Z components are presented.

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