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О некоторых проблемах использования старых магнитных данных

Some problems with old magnetic data processing

S.Y. Khomutov (IKIR FEB RAS), M. Lingala (CSIR-NGRI)



The working with archives is one of the important task of the magnetic observatories that perform long-term continuous observations.

Main tasks:

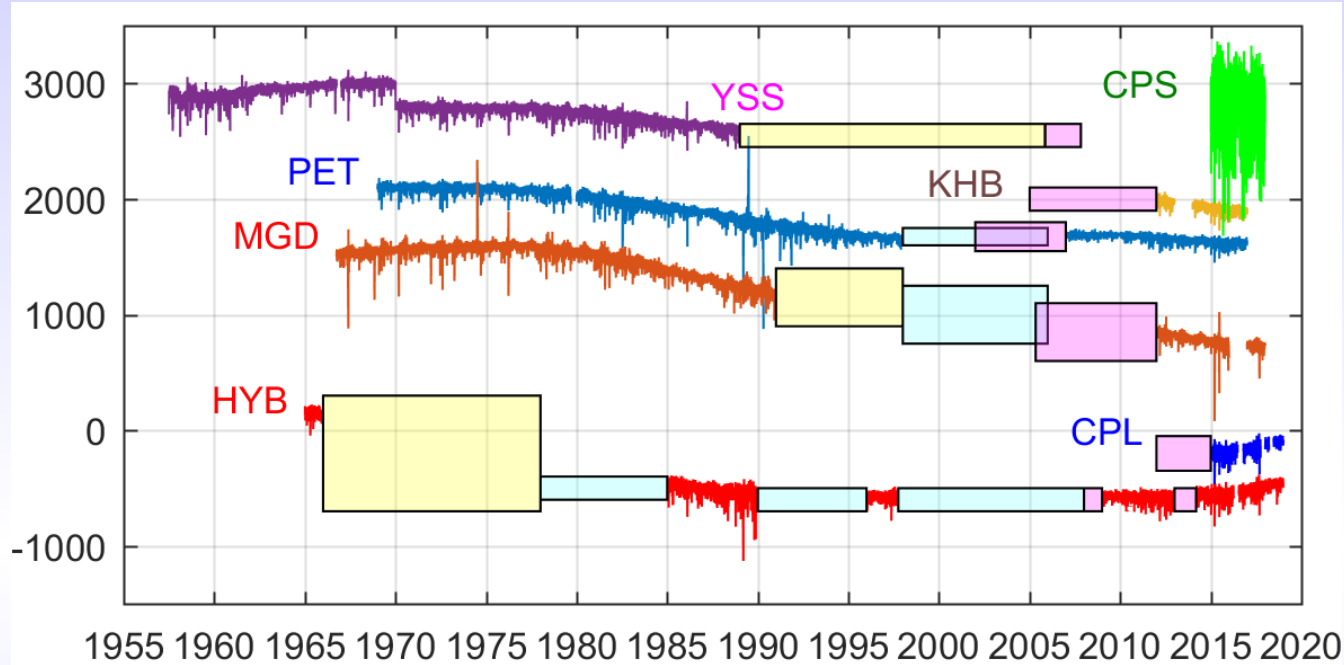
- 1) the saving of old raw data, both digital and paper
- 2) the revision of previously published data obtained from old raw data
- 3) the analysis and processing of the raw data available at the observatories, which was not previously used

The attention of the scientific community to the rescue of raw information is visible in resolutions of the international organizations, for example

- *resolution No.9 Preservation of historical materials (IDC History)*, the 8th IAGA Scientific Assembly, Uppsala, August 1997
 - *resolution No.2 Data rescue*, 10th IAGA Scientific Assembly, Toulouse, July 2005
- and in ongoing projects



State of magnetic data of IKIR observatories

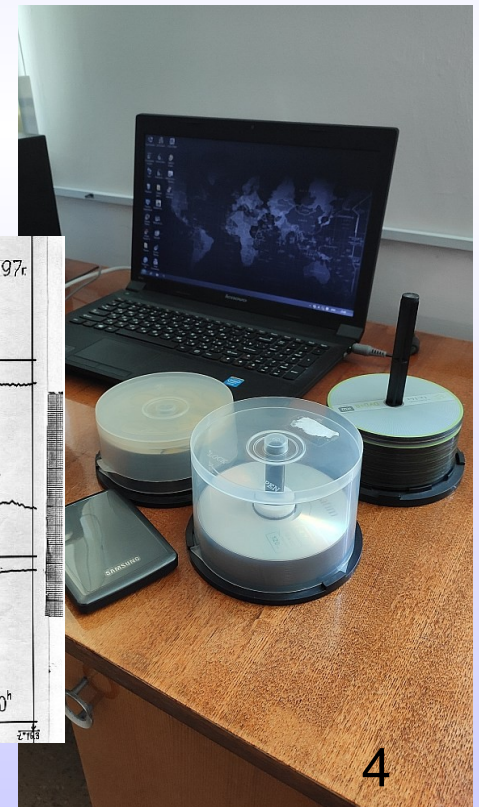
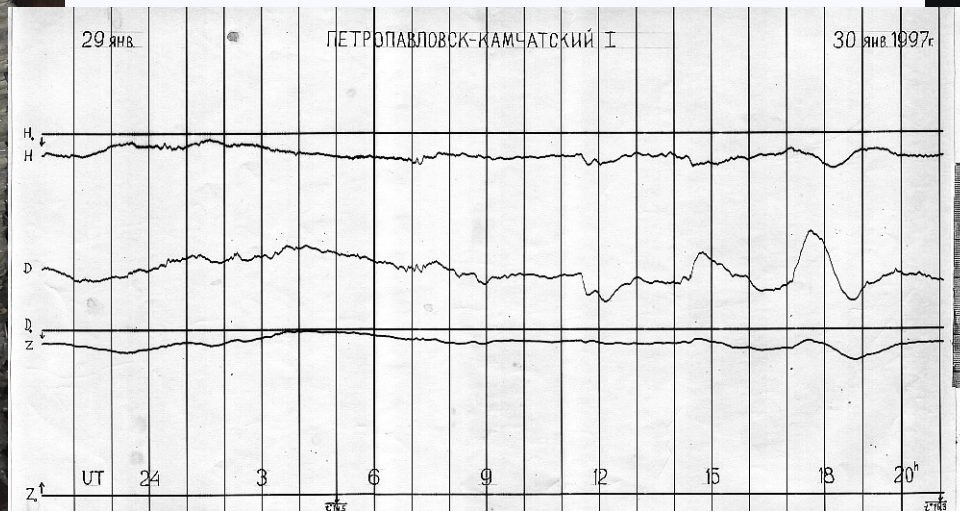


Status of magnetic data of observatories of IKIR FEB RAS and CSIR-National Geophysical Research Institute (hourly values of horizontal component H are shown as curves; state as of July 2018). Data up to 1998 are presented in the WDC (Edinburgh, Moscow), data of KHB, MGD, PET, HYB and CPL since 2007-2012 are presented in INTERMAGNET. The pink box shows periods with digital magnetometers, the blue box shows the presence of analog magnetograms (or their images), the yellow box indicates periods with an unknown data state.



1. The rescue of old raw data

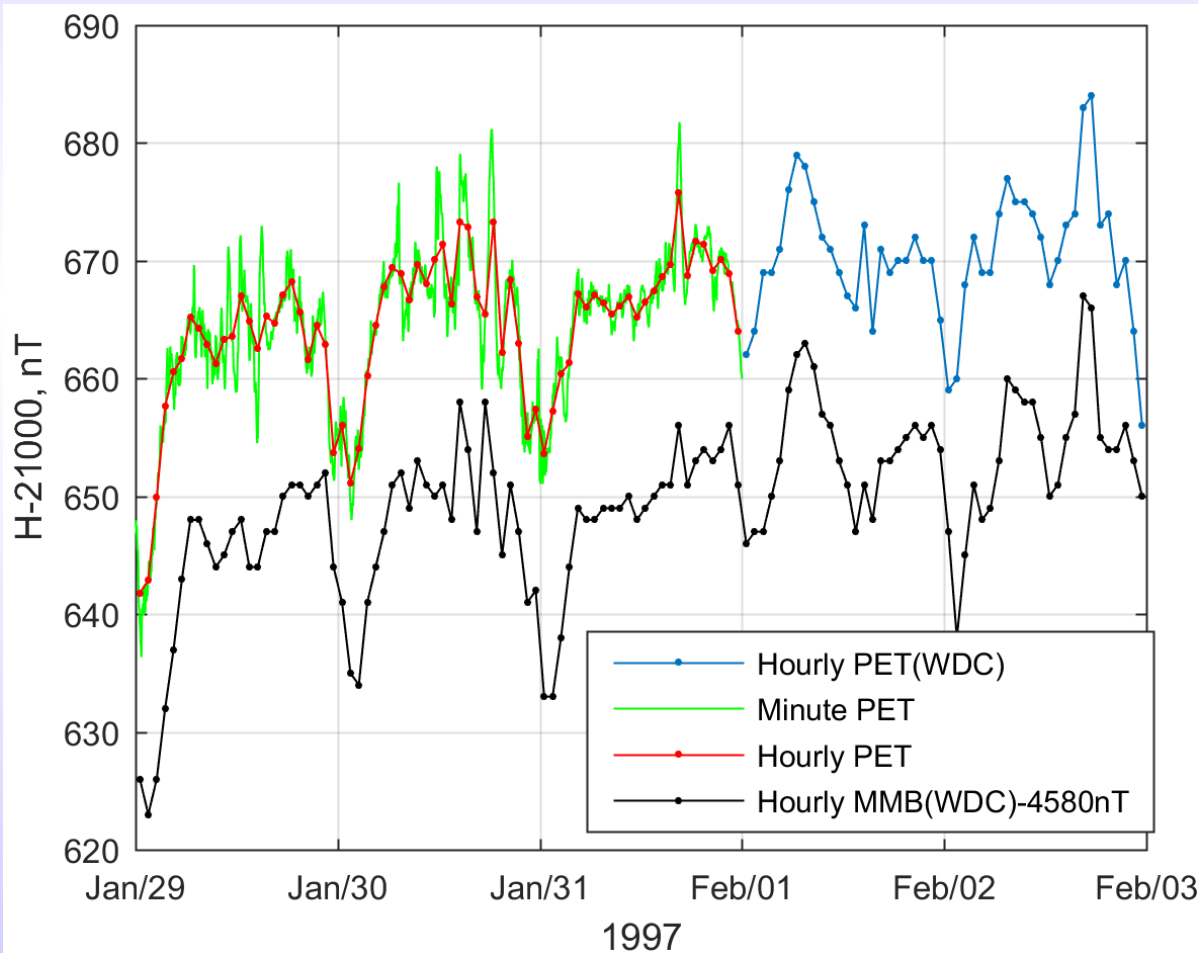
Grant VarSITI (2014) - digital images of magnetograms from the Observatory Paratunka for 1967-2006 were obtained, which are available through the WDC system (Moscow - http://www.wdcb.ru/stp/geomag/magnetogr_list.en.html, and Kyoto)





2. The revision of previously published data obtained from old raw data

The hourly data series for 1991, 1997-2000 were checked, corrected, and updated. We used the databases of hourly values already available at the Observatory, and if necessary, digitized tracks on digital images of magnetograms.



Example of filling of the gaps in the data of the observatory PET during 29-31 January, 1997 (horizontal component H, nT). Green curve—minute data obtained by digitization of the analog magnetograms; red curve — hourly data calculated from minute values; blue curve — hourly values obtained by manual processing of magnetograms (from WDC); black curve — hourly data of observatory MMB (from WDC, for comparison)



3. The analysis and processing of the old raw digital data (standard magnetometers and technique)

The retrospective processing of digital data from 2012 to 2005 does not differ methodically from the processing of current magnetic measurements at Observatory, and standard software was used to a large extent. As a result, by 2019, minute data corresponding to the INTERMAGNET Definitive status was prepared, and the data sets for 2007-2012 passed a full standard check by INTERMAGNET and were accepted. Data for 2006 is awaiting checking, and data for 2005 is almost ready.

The main difficulties during processing were related to *problems in the results of absolute observations*:

- some of the observation protocols and resulting files contained errors that were almost impossible to interpret and/or correct;
- some of the protocols were missing;
- absolute observations were not always performed methodically correctly and uniformly;
- absolute magnetometers had technical problems that were not fixed promptly.



3. The analysis and processing of the old raw digital data (standard magnetometers and technique)

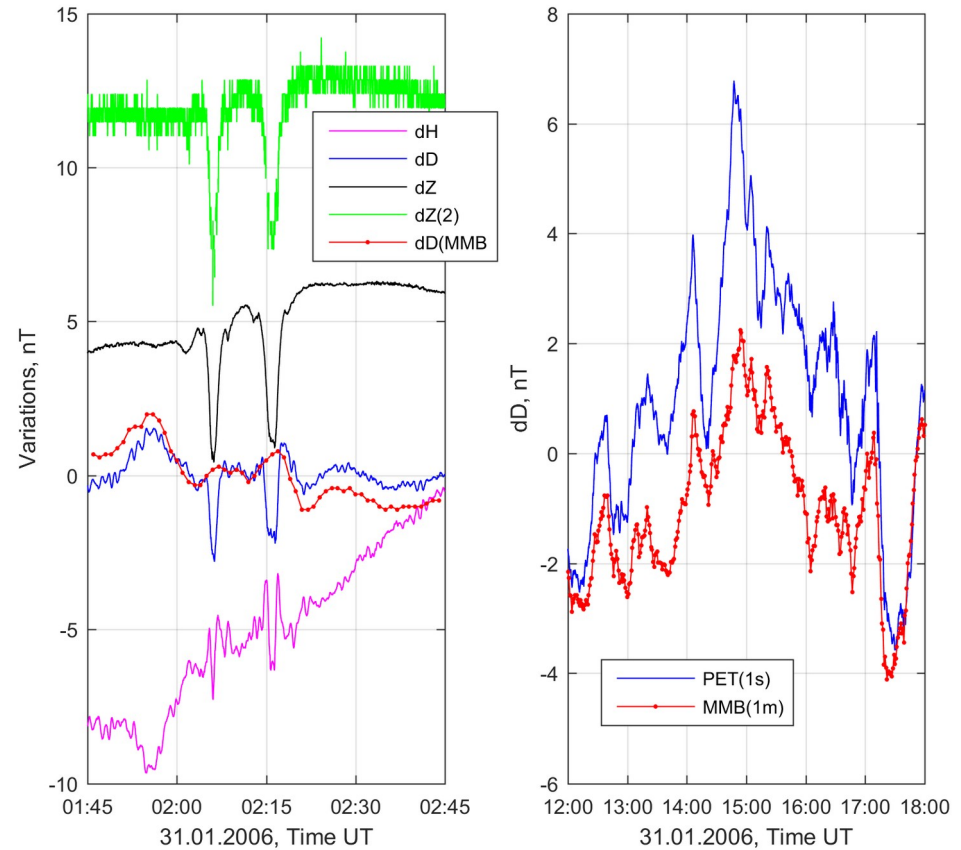
Another significant problem is *the lack of information about the conditions under which magnetic measurements were performed*, both variational and absolute.

This created difficulties in interpreting the observed anomalies in field variations or in baseline values, since it was impossible to understand the cause of anomalies - from natural or man-made sources, such as the changes in equipment parameters, work in pavilions or nearby, changes in thermal conditions, etc. As a result, some part of the noise may have been missed during processing, and the useful signal may have been deleted.



3. The analysis and processing of the old raw digital data (standard magnetometers and technique)

The example of man-made signals in magnetic record at Observatory PET. One-minute data from MMB are also presented. Left panel: the data with discussed magnetic anomalies. Right panel: the comparison of natural magnetic variations at PET and MMB.



There is no any information in the Observatory's diary about possible cause of this anomaly. The type of anomaly indicates that it may be caused by vehicles passing there and back, such as a snowmobile or tractor that cleared the road to the pavilions. At the same time, the amplitude and form of anomaly do not exclude its natural origin.



3. The analysis and processing of the old raw digital data (non-standard magnetometers)

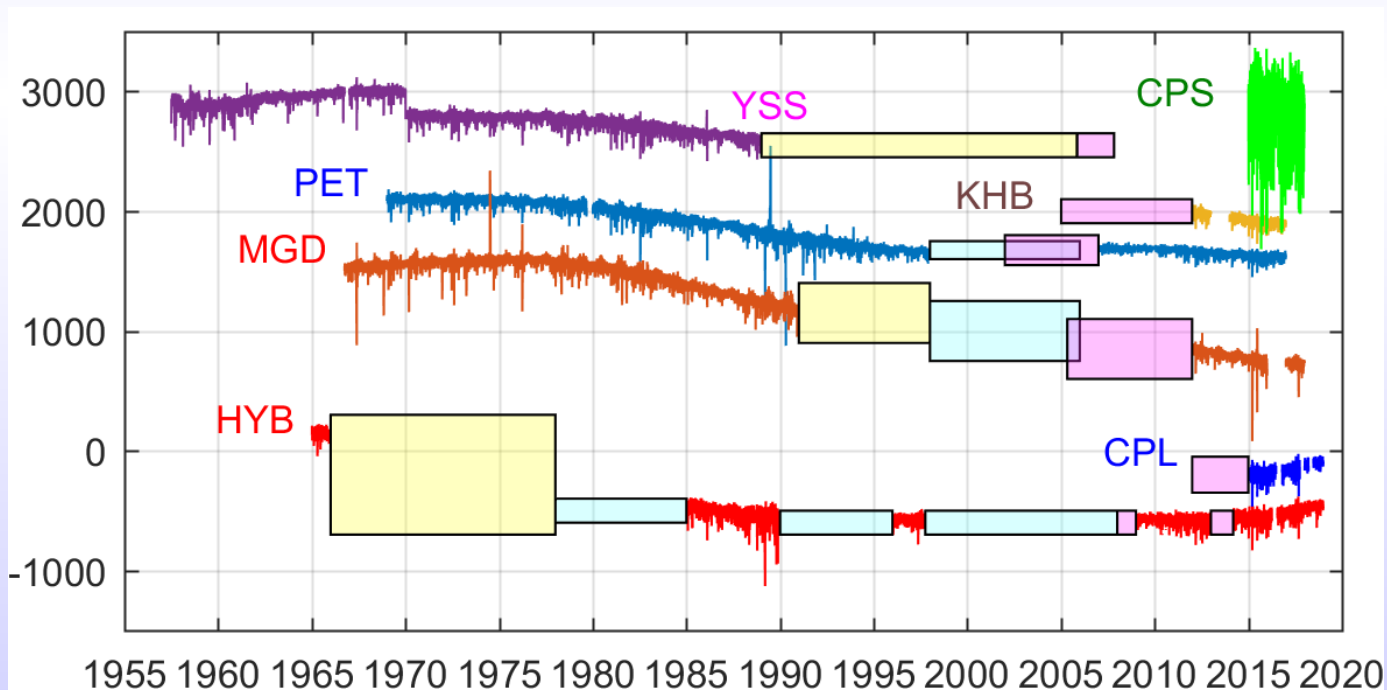
The situation with *magnetic data up to 2004-2005 differs significantly* from that described before:

- absolute measurements were performed with magnetometers that do not fully meet modern standards (quartz horizontal magnetometer and declinometer, analog proton magnetometer);
- the archives with the raw results of absolute observations are in very poor condition and cannot be used really;
- only one digital magnetometer (fluxgate variometer FRG-601) worked at the Observatory, therefore there was no backup device whose data could be used for checking main magnetometer records or filling of the gaps;
- there are no general archives with information about the conditions during magnetic measurements (metadata).



3. The analysis and processing of the old raw digital data (non-standard magnetometers)

There is a proposal *to use these hourly values for adjustment of digital variations to avoid possible instability of digital records* due to instrumental, environmental and other reasons. The main question in such technology is how much the hourly data obtained from magnetograms can be considered "absolute", that is, how correctly the full standard processing was performed, including calibration, temperature effect consideration, absolute observations and calculation of baselines, manual processing of magnetograms, etc.).





Conclusions

The rescue, maintenance, ordering and publication of archives is the most important task of science, including observatories as organizations that continuously accumulate experimental data. The work with archives of magnetic data available at the observatories of the IKIR FEB RAS has shown that there are a number of significant problems that do not allow effective use of these archived data:

- 1) *a partial or complete loss of raw results of measurements*
- 2) *the lack of metadata*, i.e. information about the conditions under which these measurements were performed

In our opinion, one of the **important conclusion** is that the data we receive now becomes archived after a while, but it does not lose its actuality. Therefore our task is to make sure that after many years the users of this data will not get the same problems that we experience when working with old archives today.



Благодарю за внимание!

(Photo by Carrey | 2018, 24 April)

(Photo by Sergey | 2020, 21 Sept)