The history and future of the geomagnetic observations in Kandilli Observatory & E.R.I., Turkey

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Abstract

There are two geomagnetic observatories running in the framework of Bogazici University, Kandilli Observatory and Earthquake Research Institute (KOERI) in Turkey. Those are Istanbul-Kandilli (ISK) and Iznik geomagnetic observatory (IZN). The former is the oldest one and started its systematic observations in 1947 and still working since then. It became a member of INTERMAGNET on its 50th anniversary in 1997. In 1947 the population of Istanbul was about one million and the Kandilli Observatory was in the country. However, nowadays the population is about 15 million and rising, so the city has begun to threaten the observatory records. Therefore, Kandilli Observatory & E.R.I., to continue the geomagnetic observations in Turkey, set up a new geomagnetic observatory, IZN, at a new site near Iznik about 100 km to the southeast of Istanbul in 2005. The new observatory is considerably far away from residential areas. Iznik is also a site of great geophysical interest because a fault segment of the North Anatolian Fault is nearby. IZN geomagnetic observatory, which is a member of INTERMAGNET since 2007, is composed of variometer building, absolute measurement building, recorder house and proton magnetometer huts. We measure geomagnetic variations using DMI three-axis fluxgate magnetometer and its three component sensor head. Inclination and declination angles of the geomagnetic field are measured by *Mag*-01H fluxgate D/I Zeiss theodolite as absolute observations twice a week. Total magnetic field is measured every 30 seconds by a proton magnetometer developed by Prof. Naoto Oshiman from Kyoto University, Japan. Geomagnetic variations are recorded in the form of second and minute mean data files. At the end of the each year, after data processing, we produce baseline and definitive data files and submit them to INTERMAGNET. In this paper, we report on our experiences, challenges and results of analysis of our geomagnetic data. These data provide valuable geomagnetic field information on Turkey, east of Europe, west of Asia. Finally, Next goal of KOERI is the creation and upgrade of new magnetic observatory at the east of Turkey with INTERMAGNET certification.

Keywords: Geomagnetic Observatory, Iznik Geomagnetic Observatory, Intermagnet

Introduction

Kandilli Observatory and Earthquake Research Institute (KOERI) is one of the oldest research centers in Turkey. It had been founded as a meteorological observatory in the city center of Istanbul in 1868. In 1911 moved to its current location, 15 km away from city center, and has been working since then. It is composed of different departments related to a wide variety of geophysical and astronomical disciplines share the 36 hectare site. One of these departments is *Geomagnetism*. Department of geomagnetism monitors the earth's magnetic field at two sites in Turkey. Figure 1 shows the location of observatories.

<u>These are;</u>

I. Istanbul-Kandilli Geomagnetic Observatory (ISK)

(Lat:41^0 03.8' N Lon:29^0 03.7' E h:130m)

I. Iznik Geomagnetic Observatory (IZN)

(Lat:40^0 30.0' N Lon:29^0 43.8' E h:256m)

Figure 1. Location of geomagnetic observatories in Turkey

1. Istanbul-Kandilli Geomagnetic Observatory (ISK)

First magnetic measurement at Kandilli was made in 1927, using a Chasselon-Brunner magnetic theodolite and a dip circle. These measurements were :

Declination :00^0 03′ 50″ E

Inclination :55^0 54′ 12″

Horizontal component : 25225.7 nT

Further measurements were made between 1936 and 1947. But these measurements were not systematic. In this period Turkish government established well-equipped non-magnetic fine new buildings. Figure 2 shows the absolute measurement building of ISK. In 1947 Askania magnetic variometers had been purchased and thus systematic geomagnetic measurements had been started in Turkey. Between 1947 and 1996 geomagnetic measurements were made as photographic records. In 1996 two sets of three component Fluxgate magnetometers and BGS Flare Data Logger were bought, and set in operation for digital data recording at the ISK. The old system was running till the end of year 2000 in order to compare the records. An example of photographic and digital records is given in Figure 3.

Figure 2. ISK Absolute Measurement Building

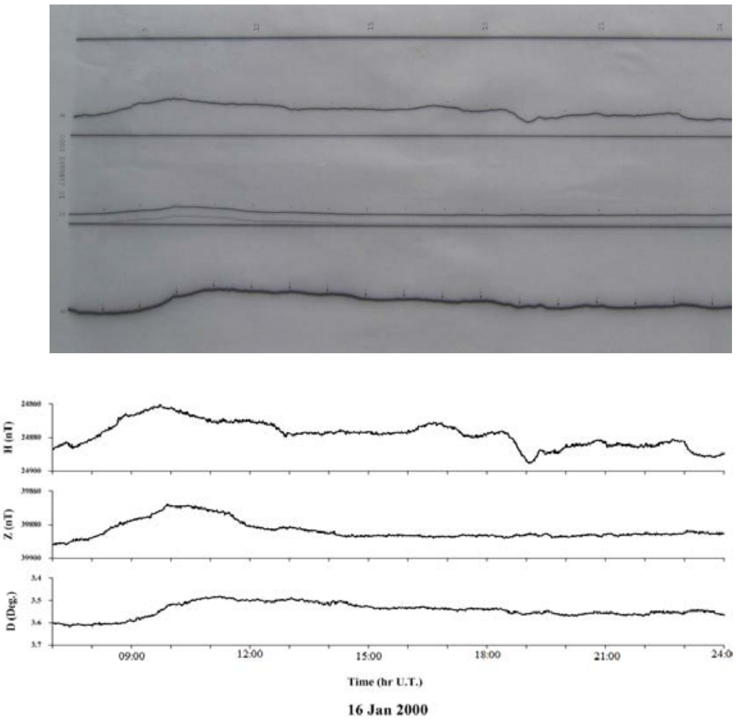

Figure 3. Photographic and Digital Records from Kandilli Observatory

In 1996 all geomagnetic data converted computer readable form, and deposited in the World Data Centers in the form of hourly mean values. ISK was become a member of Intermagnet in 1997. Figure 4 is the Intermagnet certificate of Kandilli Observatory. Unfortunately, due to poor data quality, removed from the membership of Intermagnet in 2004. Although it is not a member of Intermagnet, still continue to record geomagnetic data.

Figure 4. Intermagnet certificate of Kandilli Observatory

1.1 List of Instruments Running at the ISK

- Three-component Scintrex Fluxgate Magnetometer with BGS Flare Data Logger (HDZ),
- Scintrex EDA OMNI Portable Proton Magnetometer,
- D/I Theodolite (Figure 5).

(a) (b)

Figure 5. (a) ISK Absolute Measurement Instruments (b) Scintrex EDA OMNI Portable Proton Magnetometer

2. Iznik Geomagnetic Observatory (IZN)

In 1947 the population of Istanbul was about one million and the Kandilli Observatory was in the country. However, the population is about 15 million and still rising. Although it is in a large protected site, some geomagnetic records seem to be affected by activities in the city. In 2000, to continue the geomagnetic observations in Turkey, KOERI decided to set up a new geomagnetic observatory at a new site near Iznik (formerly Nicea) about 100 km (as the crow flies) to the southeast of Istanbul. The new observatory is considerably far away from residential areas. Construction of the new geomagnetic observatory started in 2001 and completed in 2003. After test measurements, applied to IAGA and get the code IZN for the new observatory in 2004. Under the frame of the project named '*Construction of Silk road magnetometer array and investigation of geomagnetic variations with the array and satellite data*' supported by Monbusho, and leading by Dr. Toshihiko Iyemori, Japanese team visited the observatory and installed pc-based data-logger system. With the help of Japanese team, the observatory started fully operation in August 2005. Figure 6 shows a photo of construction of the IZN with Japan team. In 2006 we applied to Intermagnet for membership. In 2007, IZN become full participating member of Intermagnet (Figure 7). In 2012, some changes have been done for the data recorder hut. We changed desktop pcs with laptop pc , and add solar panels to charge batteries for both reduction of noise and also saving energy. Figure 8 shows the measurement buildings of Iznik Geomagnetic Observatory.

Figure 6. Construction of the IZN observatory.

Figure 7. Intermagnet certificate of Iznik Observatory

Figure 8. Iznik Geomagnetic Observatory

2.1 **List of Instruments at IZNIK Geomagnetic Observatory**

Variometer Instruments;

- DMI 3-Axis Flux-Gate Magnetometer,
- DMI 3-Component Fluxgate Sensor,

Absolute Measurement Instruments;

- D/I Theodolite and its electronic box,
- OSMAN-2 Proton Mag,
  (Made by Prof. Naoto Oshiman from Kyoto University, Japan)
- SCINTREX ENVI Portable Proton Magnetometer (Figure 9).

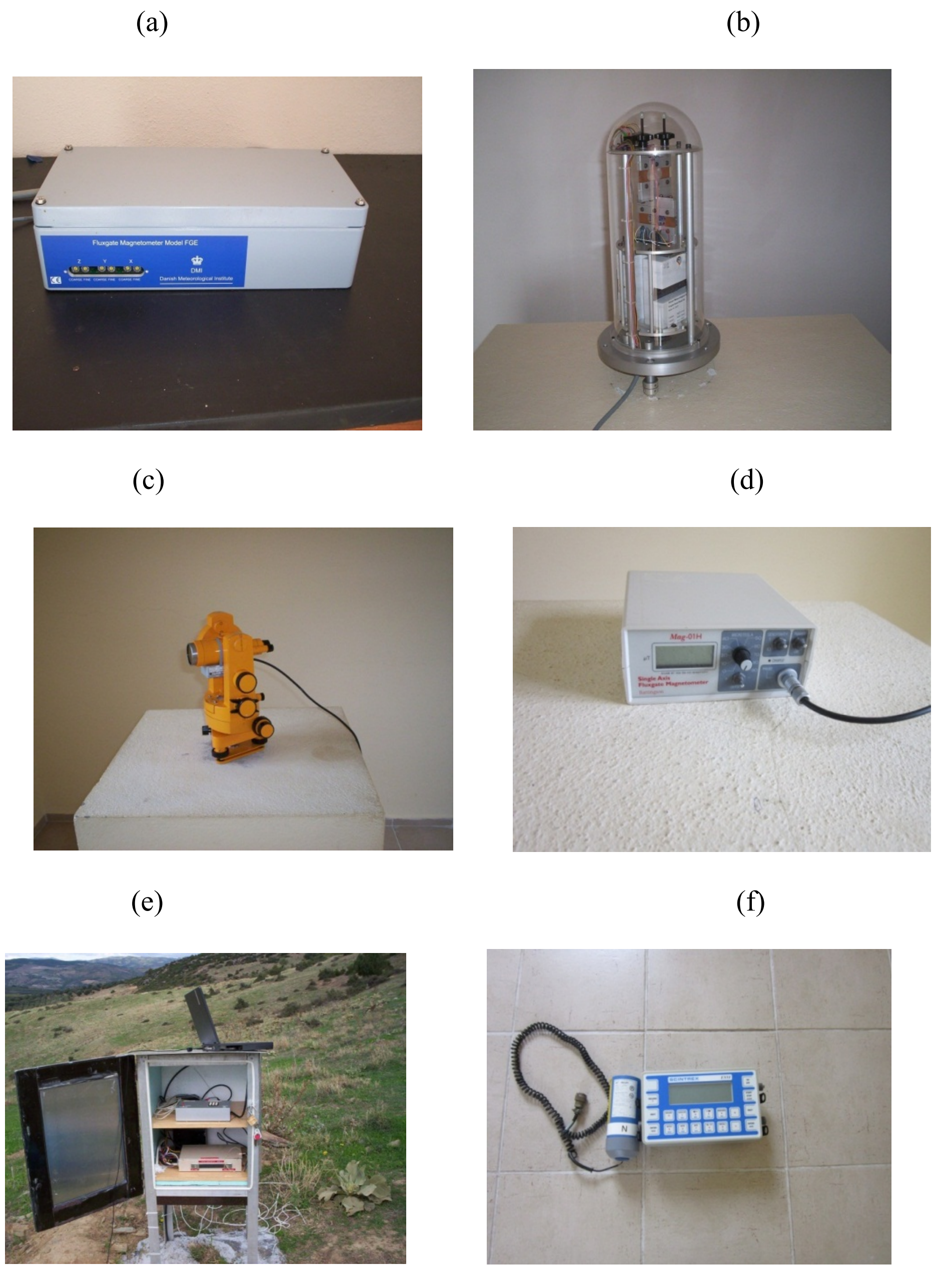

Figure 9. Instruments at IZNIK Geomagnetic Observatory (a) DMI 3-Axis Flux-Gate Magnetometer (b) DMI 3-Component Fluxgate Sensor (c) and (d) *Mag*-01H fluxgate D/I Zeiss theodolite and its electronic box, respectively (e) OSMAN-2 Proton Mag. *(Made by Prof. Naoto Oshiman from Kyoto University, Japan)* (f) SCINTREX ENVI Portable Proton Magnetometer

3. Continuous Magnetic Stations

There is a fault segment, which is called Iznik-Mekece, southern branch of North Anatolian Fault Zone passing near Iznik. Within an international project (Japan-Turk project) 7 continuous magnetic stations installed to monitor tectonomagnetic change along Iznik-Mekece fault segment in 1988. Figure 10 shows locations of the continuous magnetic stations and seismic activity from 1988 to 2011. Two more added in 2000. Some of them still working since then. Total component of the Earth's magnetic field is measured by proton magnetometers (OSMAN-2) designed and developed by Prof. Naoto Oshiman. Sampling interval is one minute. Simple differences technique is used to determine the tectonomagnetic changes. Variation of the tectonomagnetic change recorded along the Iznik-Mekece fault line is given from 1988 to 2011 in Figure 11.

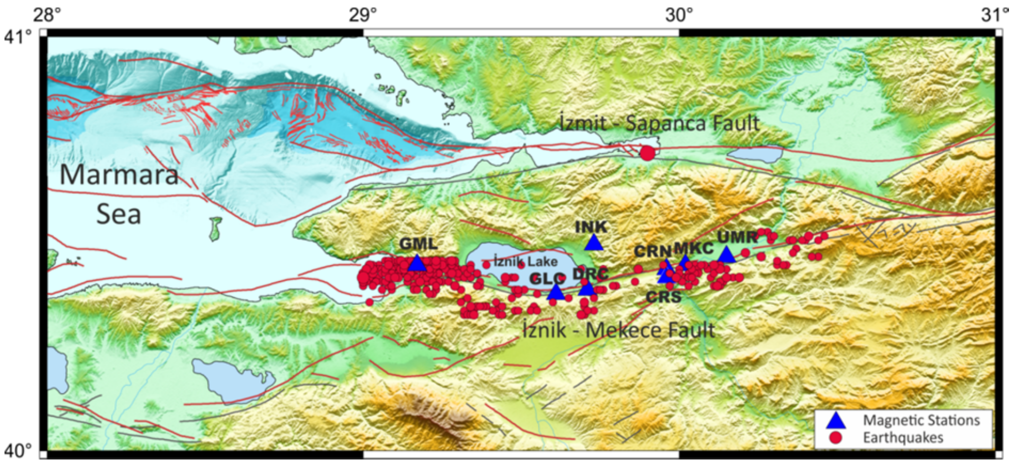

Figure 10. Locations of the Continuous Magnetic Stations and seismic activity from 1988 to 2011.

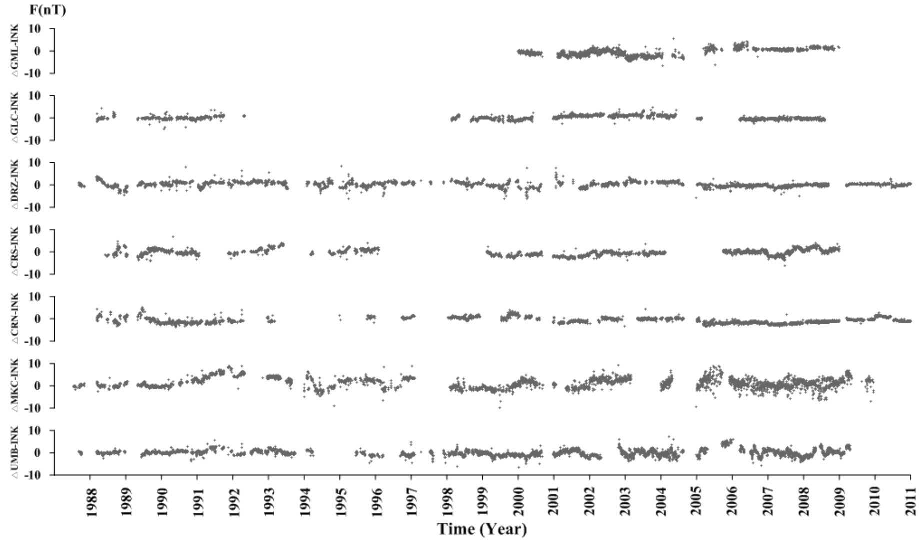

Figure 11. Variation of the tectonomagnetic change recorded along the Iznik-Mekece fault line. Any striking anomalous phenomenon associated with seismic activity is not detected. This result possibly due to the earthquakes occurred in the study area were considerably small to cause a detectable tectonomagnetic change. Gaps mostly due to the power supply problems.

In addition to tectonomagnetic changes, magnetic data from the two Kandilli geomagnetic observatories and magnetic stations have been analyzed to see the behavior of solar and lunar geomagnetic variations in the northwestern part of Turkey. The data analyzed first as a whole and then by grouping to Lloyd's seasons to see the seasonal dependence of the harmonics. As expected amplitudes of solar and lunar harmonics increase from winter months to summer months. Amplitudes of first two solar and lunar harmonics with phase angles are given in Table 1.

Table 1. Lloyd's seasons**:** D: Jan., Feb., Nov. and Dec., E: Mar., Apr., Sep. and Oct., J: May, June, July and Aug.

Obs./Station			Solar harmonics						Lunar harmonics						
			s_1 (0.01nT)	ρ_1 (0.01nT)	σ_1 (°)	s_2 (0.01nT)	ρ_2 (0.01nT)	σ_2 (°)	l_1 (0.01nT)	ρ_1 (0.01nT)	λ_1 (°)	l_2 (0.01nT)	ρ_2 (0.01nT)	λ_2 (°)	Days
ISK	**Y**	**D**	63	0	66	52	0	185	5	0	246	6	0	114	3542
		E	140	1	40	114	1	220	6	1	150	5	1	281	3612
		J	196	1	32	143	1	239	14	0	112	17	1	291	3668
IZN	**Y**	**D**	340	11	68	364	16	186	53	13	224	54	16	66	509
		E	926	20	28	888	17	204	(25)	22	132	68	18	268	521
		J	1486	14	21	1183	14	220	93	17	96	162	14	266	477
UMB	**F**	**D**	285	8	53	258	5	235	17	10	349	22	5	181	1677
		E	628	10	78	349	6	272	29	10	123	43	7	345	1749
		J	830	10	92	473	8	298	75	11	165	133	10	350	1471
CRN	**F**	**D**	291	8	54	265	7	240	19	10	9	30	7	184	1328
		E	649	11	76	347	7	272	30	11	156	38	7	348	1569
		J	814	8	90	450	8	299	77	10	153	128	8	344	1519
DRZ	**F**	**D**	306	8	48	266	5	231	23	8	349	28	6	177	1373
		E	646	12	77	342	7	274	31	12	145	35	8	344	1576
		J	822	7	89	447	10	296	84	7	154	126	10	343	1657
GML	**F**	**D**	282	14	52	241	7	238	41	16	351	31	7	130	569
		E	621	14	76	356	8	272	38	16	188	57	7	344	638
		J	764	13	92	421	10	299	84	16	160	123	11	349	717

The first two harmonics of both solar and lunar origins were calculated annually to compare with sunspot relative numbers. Solar harmonics show very good sunspot dependence, but lunar harmonics not (Figure 12).

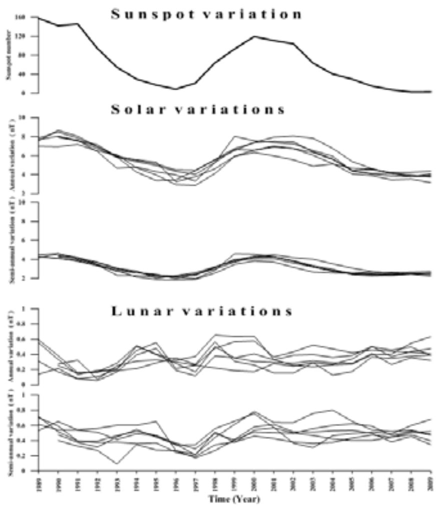

Figure 12. Solar and lunar variations in the Northwest Turkey.

4. **Conclusion**

- Two geomagnetic observatories are running in Turkey.
- Future goal of KOERI is the creation and upgrade of new magnetic observatory at the east of Turkey with Intermagnet certification,

- These data provide valuable geomagnetic field information on Turkey, east of Europe, west of Asia,
- Absolute measurements twice a week,
- Data processing,
    - ✓ Removing spikes *etc*.
    - ✓ Base-line calculation
    - ✓ Definitive data
    - ✓ Submit to Intermagnet
- Provide data for magnetic (oil and mine) surveys around Turkey for state and private companies.