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Integrated Geophysical Investigation to Locate the Grave of Nawab Jassi Khan, the Ancestor of Sudhan Tribe in Poonch Division and Adjoininig Areas of Azad Jammu & Kashmir

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Abstract: The geophysical study based on integrated microgravity, micromagnetic and electrical resistivity tomography (ERT) survey was carried out at the top of JassaPir area to locate the exact location of the JassaPir grave. The gravity and magnetic surveys were carried out using gravimeter CG5 autograve and geometrics G856 AX proton precession Magnetometer respectively. The ERT survey was carried out using ABEM Terrameter SAS 4000 (Sweden). The location of grave has been delineated by low gravity and magnetic anomalies as compared with the surrounding area. The ERT survey indicated the 1 m wide and 1.2 m deep cavity exactly on the same location of low gravity anomalies. The measured length of the grave is 6.67 feet, its width is 3.28 feet and depth is nearly 4 feet. The historical data suggested that Nawab Jassi Khan was entered in the Poonch area in the early 1300 AD or at the end of 1200 AD.

Keywords: Electrical Resistivity Tomography; Nawab Jassi Khan Grave; Magnetic anomaly; Gravity anomaly

1. INTRODUCTION

The Nawab Jassi Khan, the Ancestor of Sudhan Tribe entered in Poonch area at the end of 1300 A.D and died in 1317 A.D in Mang, District Sudhnuti and buried at the top of JassaPir Hill (Sabir, 2014). Ashraf (1997) also suggested that the Nawab Jassi Khan entered in Kashmir in 1300 A.D. Rasheed (2012) stated that the Nawab Jassi Khan entered in the Poonch area in 1250 A.D. According to Sabir (2014), he was the first Muslim ruler who entered in the Poonch area and due to his preaching, Islam spread in the surrounding areas.

There was a controversy about the grave of Nawab Jassi Khan in Azad Jammu and Kashmir and adjoining areas of Potwar, Pakistan. Local people living around the JassaPir area indicated two locations at the top of JassaPir Hill and suggested that the grave of Nawab Jassi Khan mayexistin one of theselocations. According to Subedar Aslam Khan (retd) resident of JassaPir and some other local people, the grave is located on the top of JassaPir Hill near the Bathik of Nawab Jassi Khan. Sabir (2014); Rasheed (2012) and Ashraf (1997) also suggested that the grave of Nawab Jassi Khan is located somewhere on the top of JassaPir Hill.

The integrated geophysical investigation based on microgravity, micromagnetic and electrical resistivity tomography (ERT) has been carried out at Jassa Pir Hill, Mang, Azad Jammu and Kashmir **(Fig. 1)** to exactly locate the grave of Nawab Jassi Khan, the ancestor of Sudhan Tribe. On the request of Sardar Azkar Ahmed Khan, Assistant Commissioner Mang and representatives of Nawab Jassi Khan Foundation, a team of geophysicists namely Dr. Muhammad Rustam Khan (Professor Emeritus) from Institute of Earth Sciences, University of Poonch, Dr. Abrar Niaz (Assistant Professor) and Mr. Fahad Hameed (Lecturer) from the Institute of Geology, University of Azad Jammu and Kashmir carried out the said investigation on 26th June 2018 to resolve the controversy about the exact location of the grave. The study area is located on latitude 33°49′17″N, longitude 73°37′57.8″Eat an elevation of 1921 meters. The integrated geophysical techniques have proven to be very useful for determining the location and size of cavities, voids and refilled sites below the surface (Mathews, *et al.*, 2000; Beres, *et al.*, 2001; McGrath *et al.*, 2002; Thierry *et al.*, 2005; Rybakov *et al.*, 2001, 2005).

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Fig. 1: Location map of JassaPir and surrounding regions

2. MATERIALS AND METHODS

2.1 Microgravity Survey:

The microgravity surveys have been widely used to locate the sub-surface cavities, voids and refilled sites(Colley, 1963; Butler, 1984; Bishop *et al.*, 1997; Rybakov, *et al.*, 2001; Mochales, *et al.*, 2008; Al-Zoubi, *et al.*, 2012).The gravity survey measures the variations in the earth's gravitational field caused by the density contrast in the sub-surface. The cavities, voids or refilled sites have less density as compared to the surroundings therefore, the gravity decreases considerably over there. Besides this, it is a non-invasive way to effectively demarcate the subsurface density differences and identifies the characterize sub-surface cavities, voids and refilled sites. A microgravity survey consists of making sensitive gravity measurements at discrete points on the ground surface. Spatial changes in gravity are referred to as gravity anomalies and are directly related to subsurface features with a measurable density contrast (Al-Zoubi, *et al.*, 2012). The focus of the present study was to locate the grave of Nawab Jassi Khan, so the microgravity survey was selected for this purpose. The survey was done on two sites to locate the actual location of this grave. The survey was performed in a grid pattern using the state of the art ScintrexCG5-Autograv gravity meter **(Fig. 2)**. This instrument is currently used as a standard for the microgravity surveys worldwide. Thisinstrument has a reading resolution of 0.001 mGal with residual long-term drift less than 0.02 mGal per day. A total of 16 measurements were made on the two sites, of which 11 were performed on the site 1 (Baithak) while 5 on the site 2 (Grave). The acquired data were reduced using standard procedures e.g. Hinze et al. (2013)by applying Bouguer, free-air and latitude corrections. Then the Bouguer anomaly was calculated at each station. Finally, the Bouguer anomaly maps **(Figs. 3 and 4)** of the two sites were prepared using minimum curvature gridding technique in the Surfer version 11 software.

Fig. 2: Photograph showing Scintrex CG5-Autogravgravity meter.

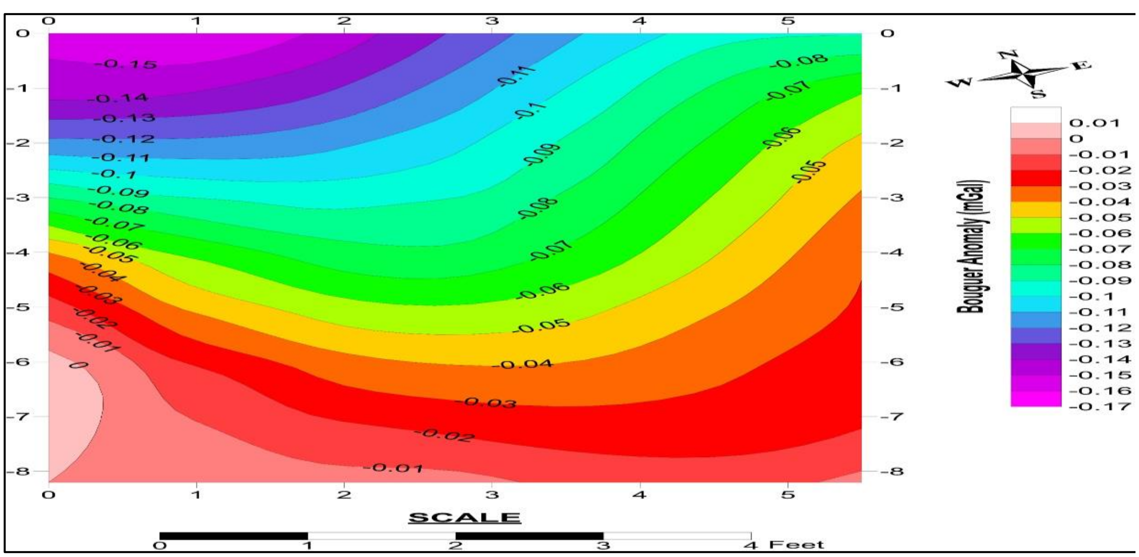


Fig. 3: Bouguer anomaly map of the site 1 (Baithak) with a contour interval of 0.01 mGal.

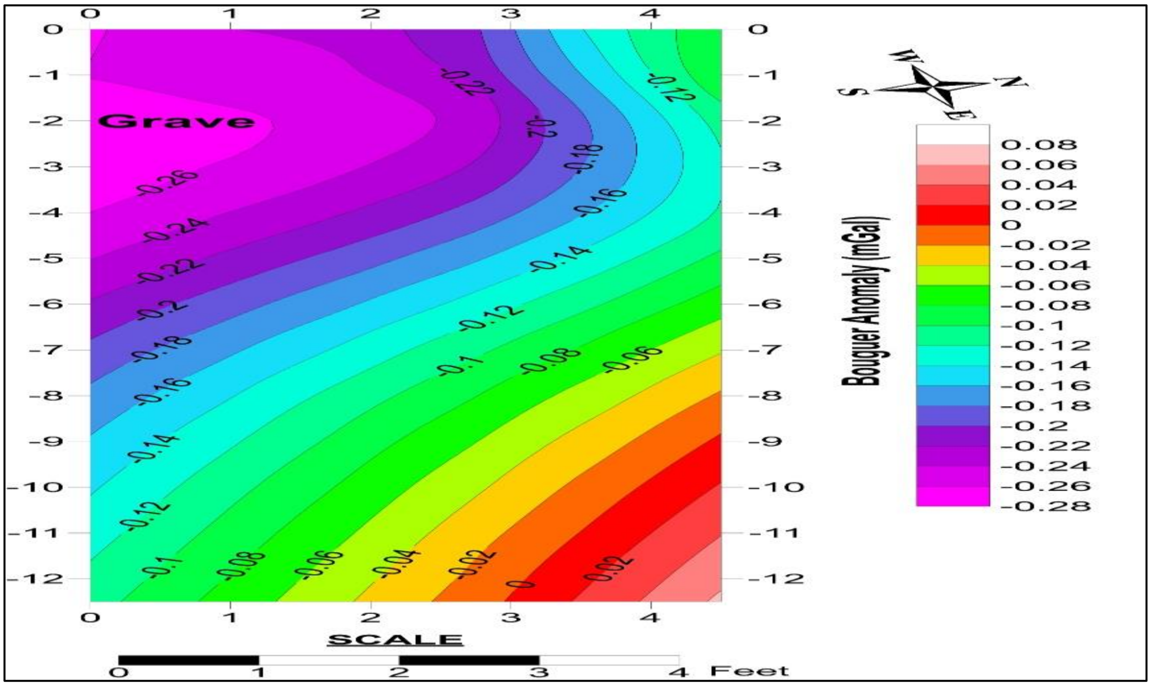


Fig. 4: Bouguer anomaly map of the site 2 (Grave) with a contour interval of 0.02mGal.

2.2. Micromagnetic Survey:

The combination of microgravity with additional geophysical surveys will give a more comprehensive and accurate demarcation of sub-surface cavities, voids and refilled sites (Al-Zoubi, *et al.,* 2012). So, it was decided to use the micromagnetic survey as well in conjunction with the microgravity survey for the exact location of the grave. The micromagnetic surveys also proved to be very useful also in detecting the cavities (Thierry *et al.*, 2005; Rybakov, *et al.*, 2005; Mochales, *et al.,* 2008).In the magnetic survey, the variations in the earth's magnetic field have been measured which are caused by the difference in the magnetic susceptibility of the sub-surface materials. The cavities, voids or refilled sites have less magnetic susceptibility as compared to the surrounding rocks in which they found. The survey was performed on one location i.e. site 2 (Grave) using Geometrics G-856AX Proton Precession Magnetometer**(Fig. 5).** It has a resolution of 0.1 nT in average conditions with an absolute accuracy of 1nT. The data were collected with intensive care to avoid obvious magnetic variations from ferrous objects and electrical fields either on the instrument operator or near the station. A total of 5 readings were taken on the site. The data were then processed by applying the standard corrections and the magnetic anomaly was calculated for each station. The data were then gridded using minimum curvature technique and finally, the magnetic anomaly map **(Fig. 6)** was prepared using the Surfer version 11 software.

Fig. 5: Photograph showing Geometrics G-856AX Proton Precession Magnetometer.

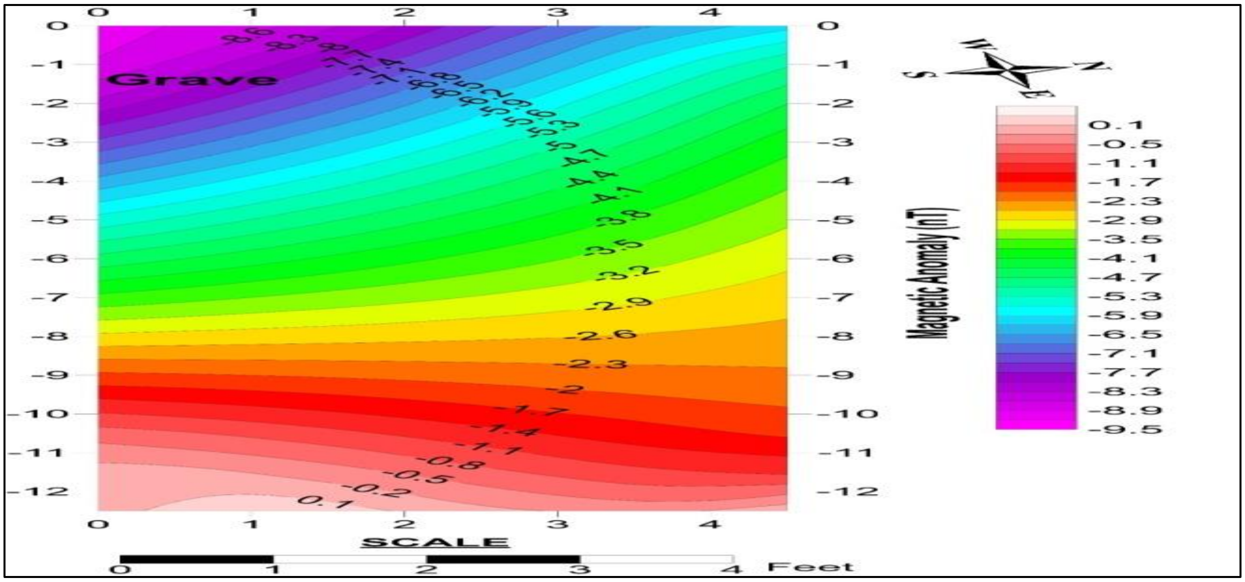


Fig. 6: Magnetic anomaly map of the site 2 (Grave) with a contour interval of 0.1 nT.

2.3 Electrical Resistivity Tomography (ERT)

The geophysical method ERT has been used beside the other two methods to locate the grave. The profile was setup across the two proposed sites i.e. Site 1 (Baithak) and site 2 (Grave). ERT is one of the most popular techniques for the shallow subsurface and is applied for hydro geological, engineering, and environmental questions (Telford *et al.,* 1990). It has been used to image structures from the millimeter scale to kilometers (Linderholm *et al.,* 2008; Storz, *et al.,* 2000). Instruments have been rapidly developing in the past decades. In most cases fully automated instruments with multiple receiver channels are used, but in large-scale applications independent dipoles for current injection and potential difference registration are used. ERT provides relatively low cost, noninvasive and rapid means of generating spatial models of physical properties of the sub surface. It is especially beneficial for contaminated land, soil creep and soil sinking related engineering, cavities and environmental issues (Hemeda, 2013).

ERT is a method that calculates the subsurface distribution of electrical resistivity from many resistance measurements made from electrodes placed in an arbitrary geometric pattern. For in-situ applications, ERT uses electrodes on the ground surface. Tomography means using any kind of penetrating wave for sectional imaging of a structure or object, while the image produced is a tomogram. The method of using electrical resistivity to partition the earth based on varying resistive properties of the earth materials to produce a tomogram is called electrical resistivity tomography. ERT has proven to be an effective geotechnical and environmental engineering tool (Zhou and Dahlin, 2003). Electrical current flow in the subsurface is primarily electrolytic. Electrolytic conduction involves passage of charged particles by means of groundwater **(Fig. 7).** Charged particles move through liquids that infill the interconnected pores of permeable materials. When an electrical resistivity tomography survey is conducted in terrain, current flow is generally assumed to be electrolytic rather than electronic. Variations in the resistivity of subsurface materials are mostly a function of lithology. Information about resistivity variations within the subsurface can be associated with different materials.

The Wenner configuration has been widely used in the investigation of horizontal variations in the sub-surface. Keeping in view, the ERT profile was examined by means of Wenner Configuration using the instrument ABEM Terrameter SAS 4000 (Sweden) and embellishments **(Fig. 8)** to stimulate the localities for the resistivity with depth in response to the electric field induced in the ground. The 31 electrodes (current and potential) were immersed in the ground. The current was introduced in current electrodes by means of cables and the resulting potential difference was measured with the assistance of potential electrodes. In Wenner arrangement, the spacing of electrodes from any particular distance of fixation was constantly increased for subsurface investigations with depth.

The acquired geo-electrical information was submitted to the iteration software RES2D in order to inspect the information from 2D geo-electric measurements on the solitary piece, automatically or semi-consequently and to get very precise results for extent, resistivity and profundity of underground stratum (Linderholm, *et al.,* 2008).

3. RESULTS AND DISCUSSION

The Bouguer anomaly map of the site 1 (Baithak) of the Nawab Jassi Khan shows a total gravity relief of **-**0.16 mGal **(Fig. 3).** Furthermore, the map demonstrates the decrease in gravity anomaly towards the northwest while the expected grave was in the centre of the surveyed area. So, based on the map interpretation it does indicate that there is no any grave in this site in the sub-surface. The Bouguer anomaly map of the site 2 (Grave) represents a higher gravity reliefof -0.3mGal (Fig. 4) as compared to the other site. This map clearly shows negative contour closure with a decrease in the Bouguer anomaly exactly above the expected grave. The contours trend also suggests the presence of a grave in the sub-surface in the north-south orientation.

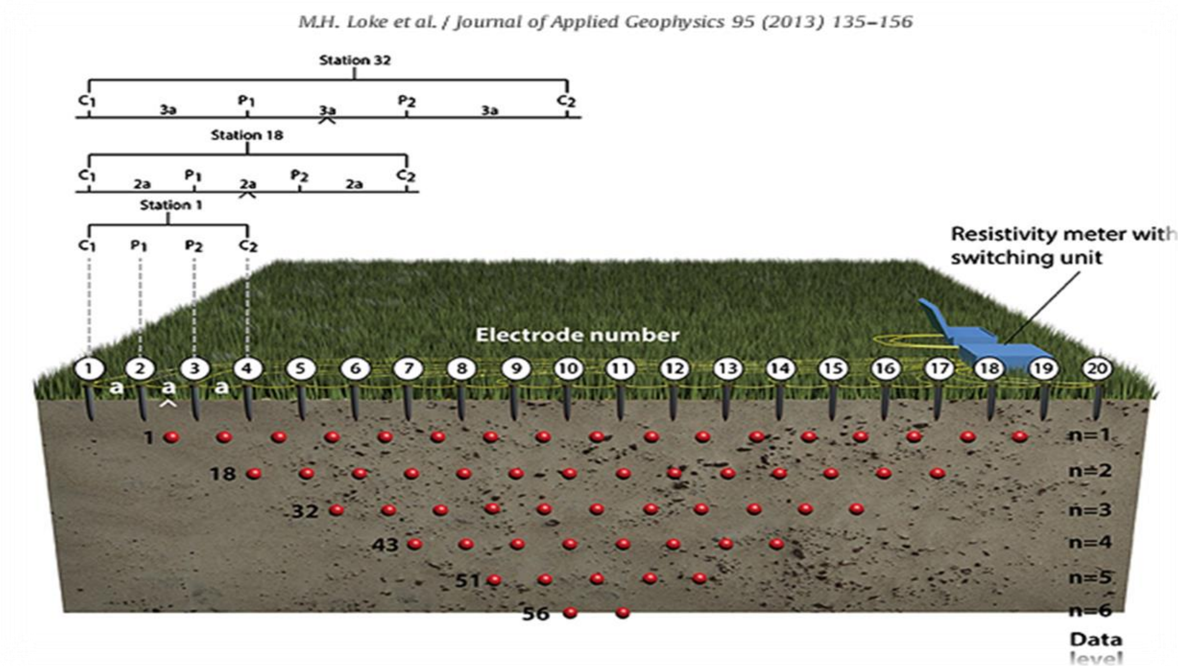


Fig.7: ERT Survey procedure and current flow pattern.

Fig. 8:Terrameter and its accessories for ERT survey.

The magnetic anomaly map of the site 2 (Grave) shows a total change of -9.6nT (Fig. 6). The map confirms the results of the Bouguer anomaly map of the same site. The magnetic anomaly also tends to decrease exactly over the expected grave and the contours trend also confirms its north-south orientation.

The ERTwasaccomplished at the Profile1 **(Fig. 9).** The exposed lithological unitsmostly comprise of clay, fillings materials, cavities, sandstone and boulders etc. The grave is detected by high resistivity at site 2 (Grave) due to the cavity with 1 m width and 1.2 m depth. The site 1 (Baithak) was delineated by ERT survey and interpreted as a big boulder of sandstone with no internal cavity here.

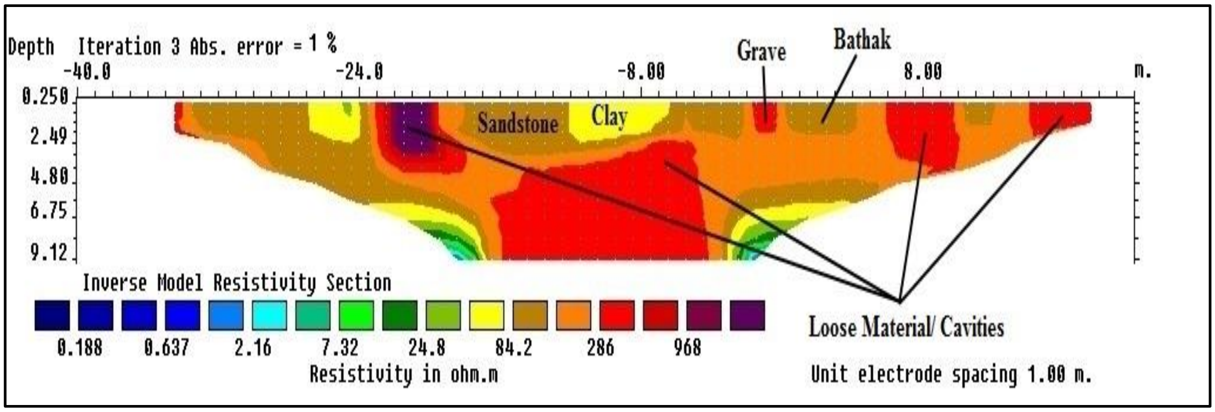
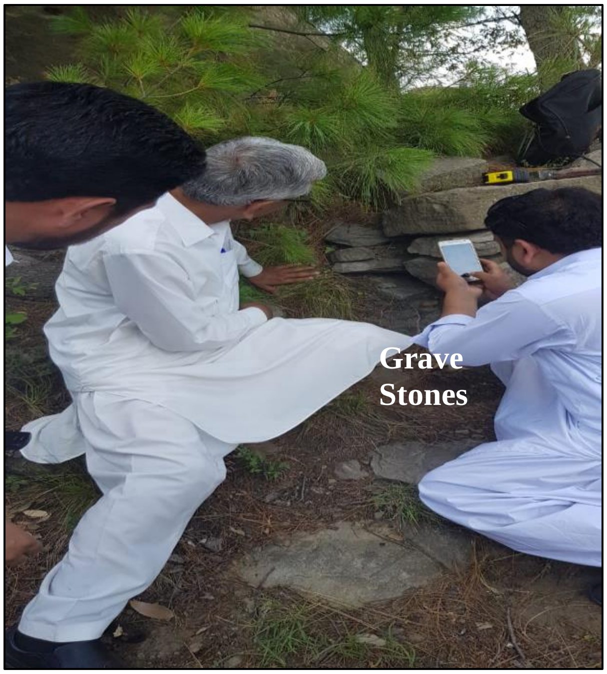


Fig. 9:ERT Wenner section along profile 1 clearly showing the grave of Nawab Jassi Khan.

3.1 PHYSICAL EVIDENCES

The geophysical study depicted the trench at latitude 33°49′17″N, longitude 73°37′57.8″E in the east of Baithak of Nawab Jassi Khan. This location **(Fig. 10)** shows8.17 feet long and 4.5 feet wide grave on the surface aligned in the north-south direction and follows the present trend of the Muslims' graves. The grave is collapsed and partially filled by some loose material. The grave stone used in the walls were prepared by the skilled stonemasons after cutting and grooving which clearly indicates the grave of a special person (Nawab Jassi Khan). The (**Fig. 11 (a))** shows the grave stone whereas **(Fig. 11 (b))** shows the very old wooden beam in the southern part of the grave.

Fig. 10: Photograph showing the grave and Baithakof Nawab Jassi Khan



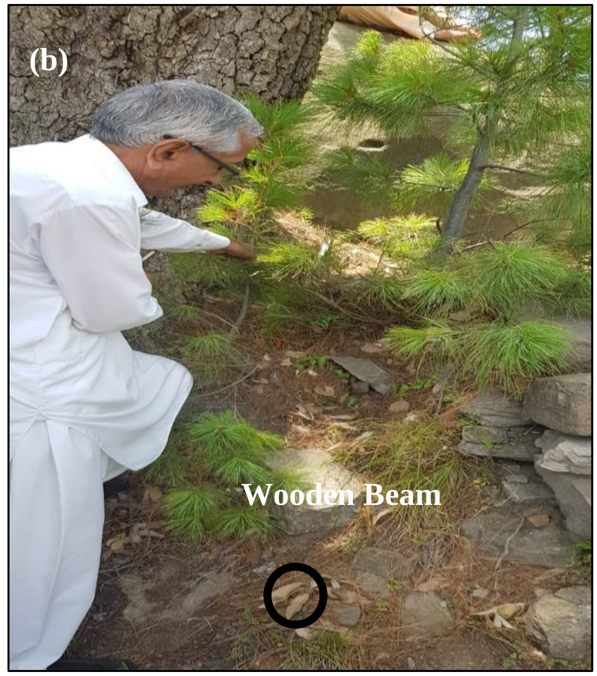


Fig. 11 (a) and (b): Photographs showing the grave stones and wooden beam used in the graveof Nawab Jassi Khan

4. CONCLUSIONS

On the basis of integrated geophysical study constrained with physical evidences the following conclusions are drawn:

1. The site 2 (grave) is the exact location of the grave of Nawab Jassi Khan while the site 1 (Baithak) was used for the praying purpose and there is no any evidence of a grave.

2. The length, width and depth of the prepared trench for the grave are; 6.67 feet, 3.28 feet and 4 feet respectively.

3. The grave is aligned in the north-south direction and follows the present orientation of the Muslims' graves.

4. Besides the geophysical data, other physical evidences like the presence of grave stones and old wooden beam also confirm the location of the grave at the site 2.

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