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A METEORITE FALL NEAR SAKAKAH
KINGDOM OF SAUDI ARABIA

by

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U. S. Geological Survey

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Directorate General of Mineral Resources

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PREFACE

In 1963, in response to a request from the Ministry of Petroleum and Mineral Resources, the Saudi Arabian Government and the U. S. Geological Survey, U. S. Department of the Interior, with the approval of the U. S. Department of State, undertook a joint and cooperative effort to map and evaluate the mineral potential of central and western Saudi Arabia. The results of this program are being released in USGS open files in the United States and are also available in the Library of the Ministry of Petroleum and Mineral Resources. Also on open file in that office is a large amount of material, in the form of unpublished manuscripts, maps, field notes, drill logs, annotated aerial photographs, etc., that has resulted from other previous geologic work by Saudi Arabian government agencies. The Government of Saudi Arabia makes this information available to interested persons, and has set up a liberal mining code which is included in "Mineral Resources of Saudi Arabia, a Guide for Investment and Development," published in 1965 as Bulletin 1 of the Ministry of Petroleum and Mineral Resources, Directorate General of Mineral Resources, Jiddah, Saudi Arabia.

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INTRODUCTION

In mid-January 1971, the U. S. Geological Survey Saudi Arabian Project learned that a meteorite fell near the town of Sakakah in northwestern Saudi Arabia during the evening of January 8. The U. S. Geological Survey is cooperating with the Saudi Arabian Directorate General of Mineral Resources in a mineral exploration program that is sponsored by the Kingdom of Saudi Arabia. A field party consisting of William R. Greenwood and Donald H. Johnson, U. S. Geological Survey geologists, and Mohammed Sultan Bahabri, Directorate General of Mineral Resources geologist, set off for Sakakah on February 23 and 24, 1971, after the end of the Islamic Holiday of Eid Al Adha, by Ministry of Petroleum and Mineral Resources helicopter and by Saudi Arabian Airlines commercial airplane. Accommodations were graciously provided at the Tapline pumping station at Badanah through the cooperation of Donald Cole, Acting Station Superintendent at Badanah, and Harry Alter, Acting Chief, Aramco office in Jiddah.

The field party visited Amir Abdullah Misha'd bin Jiluwi, Governor of the Northern Frontier Province, in 'Ar'Ar on February 24 to inform him of the proposed search. He graciously offered the considerable assistance of his office.

*Directorate General of Mineral Resources, Jiddah, Saudi Arabia

On February 25 and the days that followed, the search for the meteorite was carried out in and near the town of Sakakah (fig. 1). The search concluded March 5. Amir Abdul Rahman Sudari, Governor of Sakakah-Al Jawf, graciously assisted the search by providing the results of the investigation into the meteorite fall conducted by Abdul Kharim Salamah, Chief of Investigation in Sakakah, and also in organizing ground search parties. Abdullah al Juraid, Secretary to Amir Abdul Rahman Sudari, helped by personally coordinating and assisting in arrangements for the search near Sakakah. Gratitude must also be expressed to the many bedouin and government employees who provided information to the search party.

Field transportation was provided by Ministry helicopter piloted by Captain Gerald de Roux.

The search was conducted in three phases: (1) information collection, (2) air search, and (3) ground search.

INFORMATION COLLECTION

Information about the meteorite fall was collected by interviewing government officials and bedouin in and near Sakakah.

Location of meteorite fall

Abdul Aziz ad Dakhayel, Office Manager to Amir Abdul Rahman Sudari, indicated that the light of the falling meteorite was seen in Hail, Rafha, Turaif, Tayma, Al Jawf, and 'Ar'Ar. A truck driver reported that while driving in the Great Nafud Desert about 100 km to the south of Sakakah, he saw the light of the meteorite pass from

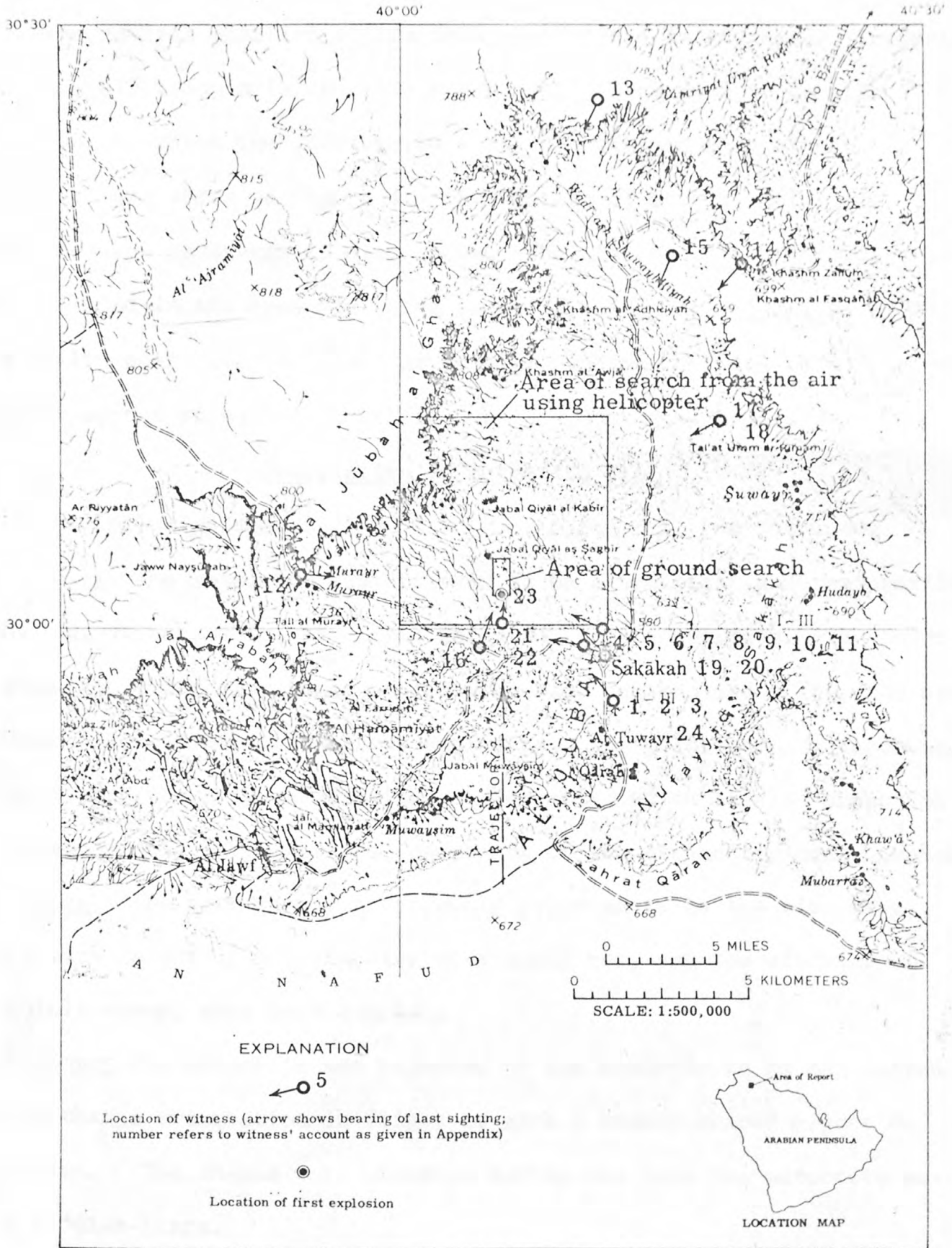


Figure 1. - Map of the Sakakah-Al Jawf area showing where the search for the meteorite was made

south to north and that he heard an explosive sound.

The general position of the fall was located by widespread interviews, and then all bedouin in the likely area were interviewed in detail. The locations at which the interviewed witnesses claimed they sighted the meteorite are shown on figure 1. The bearing of last sighting of the body from the observers is also shown. The statements of the observers are included in the Appendix. The focus of these last sightings is in the region near Jabal Al Quyal as Sahgir. The path of the meteorite near Sakakah appear to be from south to north or north-northwest.

Description of meteorite fall

The following description of the meteorite fall was obtained.

Color: The meteorite was observed to be a brilliant and temporarily blinding, silvery white to bluish white during its approach. The color changed to flame color (orange-red) when near Sakakah and changed to dark reddish black immediately before exploding. The color changes reported suggest that the body was slowing considerably, which is also supported by an apparently large vertical component of the trajectory near Sakakah.

Size: The meteorite was variously reported to be the size of a truck tire (about $1\frac{1}{2}$ m), the size of a small car, and the diameter of five full moons, when over Sakakah.

Shape: The meteorite was reported by one observer to be egg shaped and to change orientation in flight to give a kidney shaped aspect at one point. The shapes were observed during the time the meteorite was dark reddish-black.

Explosions: Although several observers in the region reported three closely spaced explosions shortly after the meteorite changed to a dark reddish-black color, only two explosions were reported from near the apparent termination point of the meteor's flight. Perhaps the discrepancy can be explained by the fact that nearby observers were able to recognize echoes.

The first explosion was reported to have occurred when the meteorite was about $\frac{1}{2}$ to 1 km above an observer at the "X" shown in figure 1 and was louder than the second. The explosions were considerably louder than any previously heard by the observers. Some observers described the sounds as being like thunder. Others described them as immense explosions. It is likely that the sound heard by the observer in the Great Nafud Desert was a sonic boom. It is also probable that the first and loudest explosion heard at Sakakah was a sonic boom.

Shock wave magnitude: In Sakakah much shaking of the ground and buildings was felt at the time of the explosions. Hinged windows and doors were opened. Dust fell from the mud-brick walls and ceilings. Some glass windows were broken in houses on the northwest edge of the town.

In Ash Shuwayhitiyah, the shaking was less than in Sakakah. No glass was broken. In Az Zalūm, moderate shaking was felt; no glass was broken. In Markhas Al Murayr, moderate shaking was felt; no glass was broken.

AIR SEARCH

The first phase of the air search involved flying at about 500 m altitude over the general area north and west of Sakakah, closely watching the ground for anomalous objects or aspects and for bedouin camps and villages. A landing was made at each camp or village, the inhabitants were interviewed, and a compass bearing was taken to the point where the people reported their last sight of the meteor. This procedure soon indicated that the probable impact point was in the vicinity of Jabal Qiyal as Saghir.

A grid pattern was then flown at about 250 m altitude over an area about 20 km square around Jabal Qiyal as Saghir (fig. 1). Grid lines were run north and south, and then east and west, with a spacing of about $1\frac{1}{2}$ kilometers. Despite careful observation, nothing indicating a possible meteorite impact was seen, so the search effort was transferred to more detailed interviews and ground search.

GROUND SEARCH

After the completion of the air search, it was learned that the meteorite probably exploded in the air. Because fragments from such an explosion seemed unlikely to be seen from the air, a ground search was made in the vicinity of the explosion. The area of search is underlain by cross-bedded sandstone which contains numerous black siliceous concretions and dark-gray to black petrified wood. The presence of black concretions and petrified wood made it difficult to tell the bedouin members of the search party what to look for. They were

instructed to report craters, pieces of shining or dark metal, pieces of iron, fractured pieces of dark-gray or black rock, rock which appeared to be partly melted, and anything they had never seen before in the area. Humaydi Michel al Ataybi led the search party of 10 bedouin provided by Amir Abdul Rahman Sudari, plus the geologists and pilot. The search commenced from the site of the first explosion and proceeded north past the approximate site of the second explosion (1 km north) and continued northward over 3 km from the starting point. The width of the ground search was about $\frac{1}{2}$ to 1 km with about 50 m between members of the search party on line. No craters or anomalous objects were discovered.

An intensive aerial search from about 30 to 60 m in altitude was then made of the same region, extending the search area to 3 km in width and 5 km down range from the first explosion. Again, no craters or anomalous areas were seen.

The results of the investigation were reported to Amir Abdul Rahman Sudari along with a request for information about any future discoveries by bedouin or government employees relating to meteorite fall.

SUMMARY AND RECOMMENDATIONS

It is clear that a meteorite did fall northeast of Sakakah at about 2100 GMT+3 on the night of January 8. It appears to have travelled in a northerly direction with a flat trajectory and supersonic speed over the Great Nafud Desert, giving off a brilliant white light. The light resulted

from the rapid oxidation of vaporized and molten material ablated from the meteorite by the friction of the atmosphere. By the time it neared Sakakah, the meteorite had slowed considerably and the trajectory became steeper. Heat produced by atmospheric friction caused the body to glow an orange-red color. Northwest of Sakakah the color changed to reddish black just before the first explosion (probably a sonic boom) was heard. After travelling about another $\frac{1}{2}$ to 1 km the body exploded. Both explosions occurred when the body was in the air. The explosion produced a large gray to black cloud which was visible in the moonlight. No fragments were seen to fall. Shock waves, probably from the sonic boom, stunned bedouin in a camp located below the first explosion. The boom also shattered windows in houses on the northwest edge of Sakakah. The three explosive sounds heard nearby may have been the sonic boom, one explosion, and a loud echo of the sonic boom. The explosion and fragmentation of the meteorite may have been caused by intense thermally-induced stresses and rapid oxidation of gases in the body.

The observations of color change and sonic boom could also be explained by an infalling satellite or spacecraft part. However, the breakup of such a body seems unlikely to produce a large black cloud as was observed at Sakakah. In addition, metal pieces of such a man-made body probably would have been reported to the authorities by the numerous bedouin and townspeople who frequent the region.

Although the search produced no fragments of the meteorite some pieces of it may be discovered in the near future. The event was unlike

anything ever experienced by the people of the Sakakah region and all expressed interest in the meteorite and helping in the search.

4.3. Shallih (Sakakah airport) and Al-Bay (Sakakah street)

We were there at 10:00 p.m. We don't know the date of the day. We were in our office and suddenly a very bright light came from the northeast of Sakakah. It was very bright and it was like a flash of lightning and it continued for more than 10 minutes. As for the light it lasted about 5 minutes and it was white and bright and similar to lightning or welding. Behind it was thick smoke. The size of that lump was five times the size of the moon. The sound was like a boom. We believe it would be preferable to visit the village of Kasa north of Sakakah.

4.4. Abdul Karim Salama (Chief of Information Services in Sakakah)

Some people and myself suddenly saw a bright white light descend from the sky from south to north of Sakakah. The color of this light changed to orange and then to dark red. The white light lasted for three minutes and the flame red for 2 minutes and then it disappeared in the mountains. After a while we noticed a very bright light and we then heard an explosion that shook the whole city of Sakakah for 5 minutes and was very loud. Then the light disappeared.

APPENDIX

1. Ramadan Shazli (Badana airport)

I have seen the light with most of Badana inhabitants.

Unfortunately I did not hear any sound. I believe it had fallen west of Sakakah.

2. & 3. Khalil Hamas (Sakakah airport) and Ali Saud (Sakakah airport)

We have seen it falling at 4:00 p.m. We don't know the date or the day. We were in our offices and suddenly we saw light passing from south to northwest of Sakakah. We heard a strong sound, stronger than the sound of thunder and it continued for more than 10 minutes.

As for the light it lasted about 5 minutes and it was white and bright and similar to lightning or welding. Behind it was thick smoke.

The size of that lump was five times the size of the moon. The earth was shaken. We believe it would be preferable to visit the village of Kara north of Sakakah.

4. Abdul Karim Salama (Chief of Information Services in Sakakah)

Some people and myself suddenly saw a bright white light descending from the sky from south to north of Sakakah. The color of this light changed to orange and then to flame red. The white light lasted for three minutes and the flame red for 2 minutes and then it disappeared in the mountains. After a while we returned to our places and we then heard an explosion that shook the whole city of Sakakah for 5 minutes and even more. Then the sound was broken down.

5. Sheikh Abdulaziz Ben Dakhil (Secretary to the Prince of Al Jawf, Sakakah)

Most of the people had seen the flaming mass descending from the sky - I saw it myself going from southeast to the northwest and it was all a flaming mass. It was white in color and others stated that it had several colors: white, yellow, green and red.

6. Nasser Suweid (Chief of Assafieh Center)

Nearby Tima which is 400 km west of Sakakah, the strong light was seen at 3:00 p.m. (Arabic time). I remember some said that one day before the appearance of such light a star fell in Naja which is around Grayat, which is 480 km west of Sakakah. The exact place is not really known.

7. Shayee Afraj (one of those sent by the Prince of Sakakah to gather information on this incident)

We first went to Marayr Center 40 km away. The people there told us that they saw a light falling down. We moved then to Jabal Gayyal and the bedouin indicated that the light fell away from their area. We came down the mountain and the bedouin said that the light fell on them. They heard a lot of noise and clamor that made them close their eyes from fear. They didn't know the exact place on which the light fell upon. We went then to Zalūm Center, north of Sakakah and the inhabitants of that area informed us that the light fell west of Quyal. That's all the information we managed to collect.

8. Muraijel Ibn Mubarak

I was sleeping and I woke up from fear and severe noise. When I asked about the matter, the people around didn't know what had happened.

9. Musa Suleiman (driver from Sakakah)

It was a flame! I saw it when I was in Nafud driving quickly from south to the north. Its color was white and had an explosive sound.

10. Shafi Atturqu (a student)

The light was very bright, white in color and similar to lightning. It had smoke like that of an airplane. It made a strong sound. It came from south to north.

11. Abdullah Sharari

After Isha, I saw a bright white light. It was like daylight. It was like a line then it became red and blue in color.

12. Shaddad Ben Shaal

About 4:00 p.m. (local Arabic time) a bright light appeared from southwest, then a strong sound came about. The light turned red and it was accompanied by smoke. A disturbing sound came later and we did not know anything else. The direction was N 80°E. The earth shook for 5 minutes. The sound was continuous. Then it broke down and it was similar to the sound of breaking rocks. I advise that you visit Jabal Jouya.

13. Shujaa Usseimi (a bedouin in one of the tents)

At 4:00 a.m. when praying at dawn, I saw a strong light star-like in shape and having a thunder-like sound. It was from east to west

and when it fell, it made a gun-shooting sound. It was big in size and I think it fell in Wadi Rahan.

4. Ferdas Ben Hishal (a bedouin in one of the tents)

I come from Buweib, left side of Tureif road. I saw the light which was like lightning and I heard the strong sound. I believe it fell in between our area and that of Sakakah - south to us.

15. Aqla Samhan

I saw a strong white light. It was like lightning. The color was white, then red and it turned orange. It was soundless. After it disappeared, it made a strong thunderlike sound, then earth shook and the sound broke down. The earthquake was less than that of Sakakah. Its direction was from north to south. The size was larger than a Mercedes tire.

16. Idah Bint Shamroukh (a woman from west of Sakakah, wife of Jaed Ruweili)

I saw the light and it was like lightning. The night turned day. The sound was strong and the earth shook beneath us. It went towards the mountains.

17. Amir Feyhan Dabeeb (Amir of Zallūm)

I only heard the sound and saw the light. I believe Saad Damak will tell you in detail about this matter. Its color was like that of mercury.

18. Saad Damak (employee at Zalūm Center)

At 9:00 p.m. I was outdoors and the moon was shining and there were some clouds. Suddenly, a moon-like light appeared, I thought

that one of the clouds had moved away from the moon. But, the light increased and I could see everything around me as in daylight. I couldn't open my eyes for a moment. Then I opened my eyes and started to observe this strange body. It was as big as a truck and was burning and flame-red in color, followed by a line of smoke just like that of a jet. This body became black, red, or even dark brown. We heard it hitting the ground and 2 minutes later, it hit the ground again. Then after a while the mountains around us echoed and the earth began shaking. Dust came from the ceilings of some houses. Direction was S 65 W. The smoke was grey in color.

19. Mohammed Ali Marwat (a landlord)

I heard the sound and saw the light. But it fell away from us.

20. Abdul Karim Nazai (from Sakakah fields)

I saw the light and I believe the sound was made in the air. The light's direction was from east to west.

21. Hashel Sind (student in Sakakah school)

I was repairing my motor-cycle west of Jabal Gayyal. Suddenly I saw a strong light coming from the sky and the night turned day. Then its color changed from white to dark red and an explosion took place above my head. I believe some parts of it fell on the ground. Also I think that this explosion was $\frac{1}{2}$ or 1 km away from my head.

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