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GUBA-CHICHI STONE

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This study presents the preliminary analysis of an unusual stone specimen discovered in the vicinity of Chichi village, Quba district, Azerbaijan. The stone drew attention due to its higher brightness, hardness, and weight compared to ordinary rocks. Initial chemical and phase analyses revealed that it is mainly composed of iron (Fe) and silicon (Si) minerals. The specimen's weight (~3.4 kg), volume (~508 cm³), and density (~6.65 g/cm³) were determined. These results suggest a possible cosmic origin of the stone. Further investigations are required to confirm whether the specimen is indeed a meteorite.

Keywords: meteorite, stone, phase analysis

Introduction

Meteorites are fragments of asteroids, comets, or other celestial bodies that originate in space and survive their fiery passage through the atmosphere to reach the surface of a planet. As meteoroids enter the Earth's atmosphere at very high speeds, they heat up intensely, glow, and often burst into flames. This process creates a bright streak of light, commonly known as a "shooting star." When the incoming meteoroids are large enough, parts of them can survive atmospheric entry and reach the ground as intact fragments.

Meteorites are of great scientific importance because they serve as time capsules, preserving invaluable clues about the formation and early history of the Solar System, the age and composition of planets, and even the origins of life on Earth. They contain primitive material left over from the infancy of the Solar

System and can shed light on the conditions of other celestial bodies. Moreover, large meteorite impacts have profoundly influenced Earth's history, sometimes triggering mass extinctions and reshaping planetary landscapes.

The study of meteorites helps scientists understand fundamental processes, such as how planets formed from dust and gas in the early Solar System. Therefore, the discovery and investigation of new cosmic bodies remain highly relevant today.

Sample Description and Initial Analysis

This article is dedicated to the preliminary investigation of a stone fragment (or rock) discovered near of Chichi village, Quba district, Azerbaijan. The stone's shape resembles a parallelepiped, with dimensions ranging from 6 to 10 cm (Figure 1). Its volume is approximately 508 cm³, weight ~3.4 kg, and calculated density ~6.65 g/cm³.

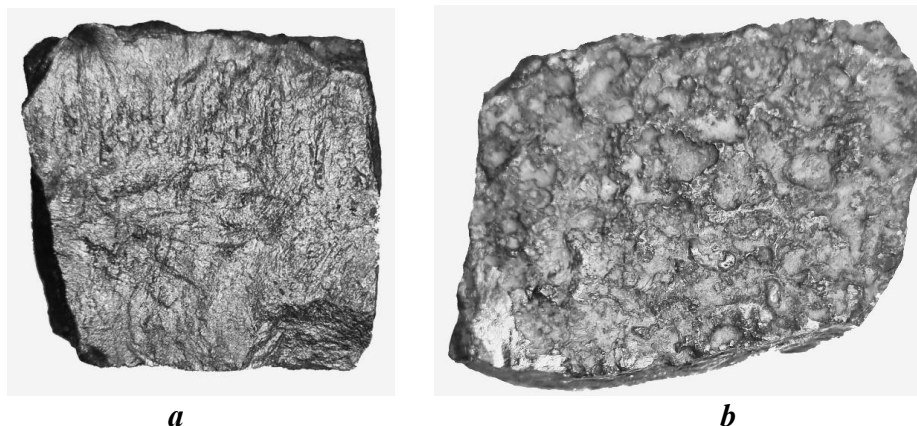


Fig.1. Photograph of the Chichi stone

To obtain initial information about the specimen, its potential radioactivity was examined. Detector measurements showed that the stone's radioactivity level was at background values. Subsequently, elemental composition analysis was carried out using a x-ray fluorescence spectrometer. The obtained results are presented in Fig. 2 and Table 1. As can be seen, this preliminary analysis demonstrated that about 96.45% of the rock's composition consists of Si, Fe and Al elements. The amounts of other elements (Al, Na, K, Mg, Ca, Cr, Mn, Cu,) are each below 0.6%, together accounting for ~3.5%.

The elemental analysis of a ground sample weighing about 2 grams, carried out using a Bruker S6 Jaguar instrument, showed similar results. That is, the stone consists mainly of the elements Fe and Si. However, the simultaneous presence of nickel, which is characteristic of iron meteorites, *was not observed* in this sample. Therefore, a more thorough study of both the composition and the origin of the stone is of great scientific importance. Following this information, phase composition analysis of the rock became necessary, and the results of these investigations are presented below.

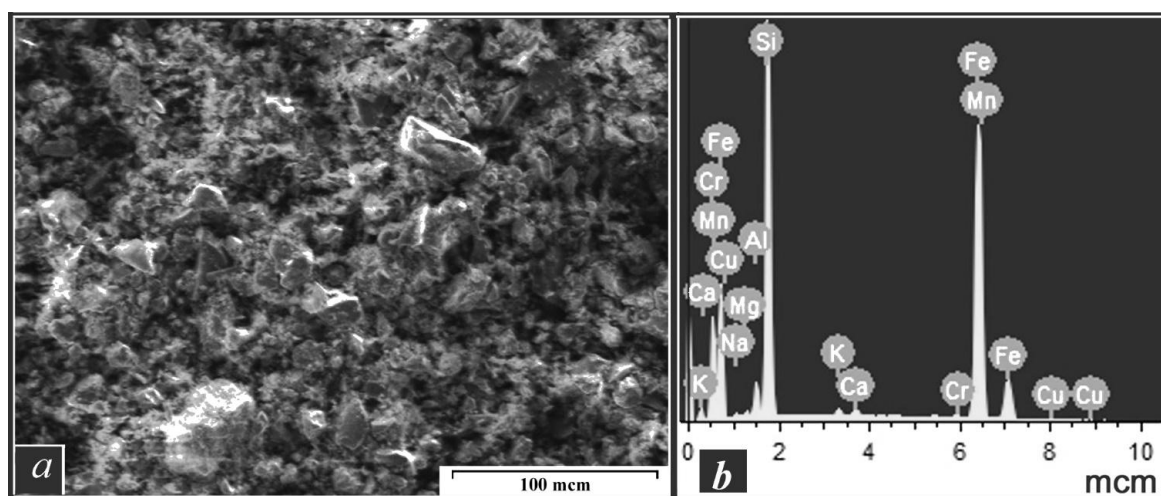


Fig.2. Photo (a) and EDS spectrum (b) of stone

Table 1

Elemental composition of the rock

Element	Weight %	Atomic %
Na	0.56	1.05
Mg	0.32	0.57
Al	2.37	3.77
Si	26.31	40.19
K	0.49	0.54
Ca	0.47	0.50
Cr	0.35	0.29
Mn	0.49	0.39
Fe	68.32	52.49
Cu	0.31	0.21
Total	100.00	100.00

X-ray Phase Analysis of the Rock

A visual inspection of the stone's surface suggests that it is a fragment of a larger rock and appears fairly homogeneous. A small portion of the stone (approximately 2 grams) was ground into powder, and its diffraction spectrum was obtained using a **BRUKER D2 PHASER** diffracto-

meter. Based on these data, the phase composition of the rock was determined. The lattice parameters of the identified mineral phases were further refined using the **Le Bail method** with the **EVA** and **TOPAS-4.2** software packages (Fig. 3).

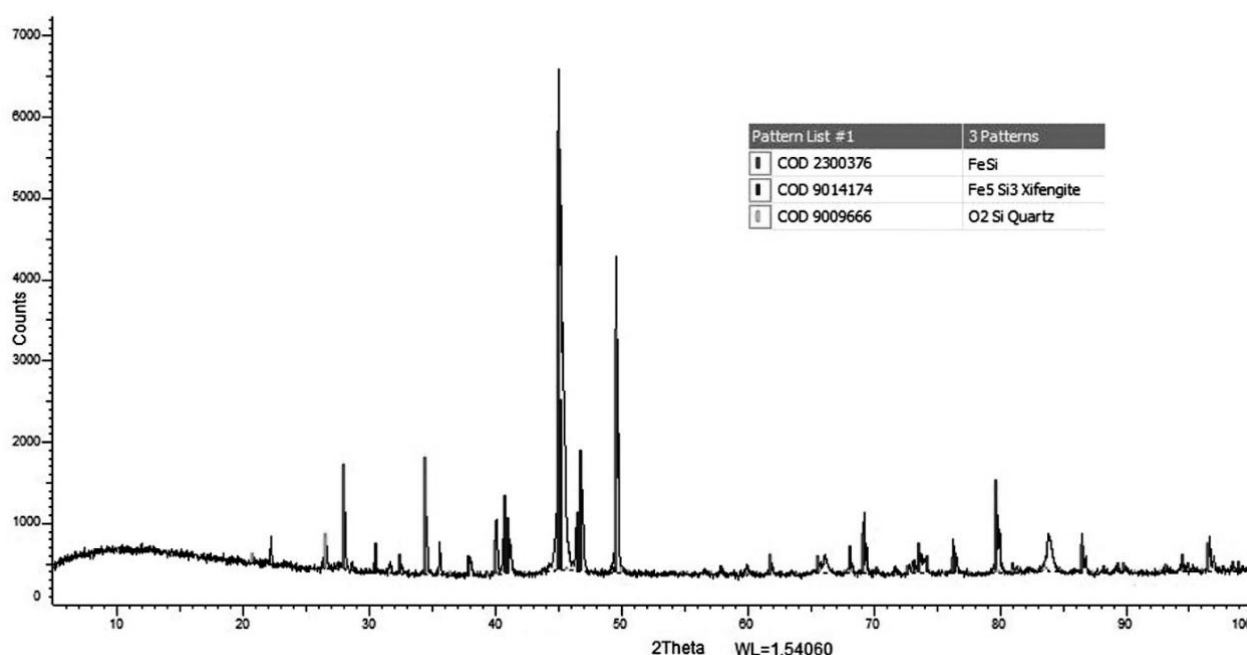


Fig. 3. Diffraction spectrum of Quba-Chichi stone

The **phase analysis**, performed using the **Rietveld method**, showed that the rock mainly consists of two minerals: **FeSi** [1, 2] and **Fe₅Si₃** [3, 4]. The crystal structures of these minerals correspond to the **cubic P2₁3** and **hexagonal P6₃/mcm** space groups, respectively. The refined lattice parameters obtained by the Le Bail method are as follows:

FeSi, *sp.gr.* **P2₁3**, $R_{Bragg} = 1.80$, $a = 4.4953(1)$, $V = 90.841 \text{ \AA}^3$;

Fe₅Si₃, *sp.gr.* **P6₃/mcm**, $R_{Bragg} = 1.35$, $a = 6.7117(5)$, $c = 4.7921(8)$, $V = 186.95(4) \text{ \AA}^3$.

Based on the results of compositional analysis, it can be said that each of these phases is present in approximately the same amount in the rock.

As can be seen, the analysis of the diffractogram also shows that a small amount of

SiO₂ is present. It is a well-known phenomenon that meteorites heat up to high temperatures as a result of friction when they enter the Earth's atmosphere. We think that it is possible that the formation of SiO₂ on the surface of the hot rock, which is rich in Si element, occurs as a result of contact with oxygen in the air. It should be noted that the relatively low-intensity peaks at $2\theta = 22.238^\circ$; 30.500° ; 35.621° remain unindexed. It is assumed that these peaks may correspond to compounds formed by elements other than Fe and Si present in the rock, indicating the need for more detailed future studies of the specimen. Below, **Table 2** presents information on all known meteorites containing **iron silicide (Fe–Si)**.

Table 2

Known meteorites confirmed to contain iron silicides (Fe-Si)

Meteorite	Classification	Fall / Found (year) & location
Abee	Enstatite chondrite — EH4	Fell 1952 — Abee, Alberta, Canada (107 kg recovered)
Indarch	Enstatite chondrite — EH4	Fell 1891 — Indar/Indarch, Azerbaijan (≈27 kg)
Kota-Kota	Enstatite chondrite (paired/unequilibrated; often referenced with EH3/EL grouping in literature)	Found 1905 — Kota-Kota (Nkhotakota), Malawi,
Saint-Sauveur	Enstatite chondrite — EH5	Fell 1914 — Saint-Sauveur, France (~14 kg reported)
Qingzhen	Enstatite chondrite — EH (type 1 / equilibrated)	Fell 1976 — Qingzhen (Guiyang area), Guizhou Province, China
Sahara 97072	Enstatite chondrite — EH3	Found 1997 — Sahara find (North Africa), mass ~1270 g (EH3 group)
North Haig	Ureilite (olivine-pigeonite achondrite)	Found (Western Australia) — sample studied in 1982 (ureilite)
Dar al Gani (DaG) 319	Polymict Ureilite	Found 1997 — Dar al Gani, Libya (740 g fragments)

Visual observation of the rock suggests that four of its six faces were formed by mechanical fracture, while the opposite two faces appear to have been smoothed and vitrified, likely as a result of exposure to high temperatures. Such high temperatures are known to occur when cosmic bodies enter the Earth's atmosphere due to friction with the air (Fig.1,b). In other words, the observed surface morphology also supports the hypothesis that the specimen may indeed have a meteoritic origin.

Thus, if the Guba-Chichi stone is confirmed to be of cosmic origin, it is possible to say that it would belong to a rare type and would be the second specimen found in Azerbaijan.

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Chichi village, Quba, for respectfully presenting the stone fragment for analysis.

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QUBA-ÇİÇİ DAŞI

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Bu tədqiqatda Azərbaycan Respublikasının Quba rayonunun Çiçi kəndi ərazisində aşkar edilmiş qeyri-adi daş nümunəsinin ilkin elmi təhlili aparılmışdır. Nümunə, tipik süxurlarla müqayisədə daha yüksək parıltısı, bərkliyi və kütləsi ilə fərqlənərək diqqət cəlb etmişdir. İlk kimyəvi və faza analizləri göstərmişdir ki, nümunənin tərkibi əsasən dəmir (Fe) və silisium (Si) minerallarından ibarətdir. Ölçmələr nəticəsində onun kütləsi (~3,4 kq), həcmi (~508 sm³) və sıxlığı (~6,65 q/sm³) müəyyən edilmişdir. Elde olunan göstəricilər nümunənin mümkün kosmik mənşəli olduğunu ehtimal etməyə imkan verir. Bununla belə, daşın meteorit mənşəyini qəti şəkildə təsdiqləmək üçün əlavə kompleks tədqiqatların aparılması zəruri hesab olunur.

Açar sözlər: meteorit, suxur, faza analizi

КАМЕНЬ ГУБА-ЧИЧИ

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В настоящем исследовании представлен предварительный анализ необычного каменного образца, обнаруженного в окрестностях села Чичи, Кубинский район, Азербайджан. Образец привлек внимание вследствие повышенной светимости, твердости и массы по сравнению с типичными горными породами. Первичный химический и фазовый анализ показал, что образец преимущественно состоит из минералов железа (Fe) и кремния (Si). Были определены его масса (~3,4 кг), объем (~508 см³) и плотность (~6,65 г/см³). Полученные результаты позволяют предположить возможное космическое происхождение камня. Для окончательного подтверждения гипотезы о метеоритном происхождении образца необходимы дальнейшие комплексные исследования.

Ключевые слова: метеорит, камень, фазовый анализ