Journal of Mining and Environment (JME), Vol. 11, No. 4, 2020, 1039-1046

Shahrood University of Technology

Iranian Society of Mining Engineering (IRSME)

Journal of Mining and Environment (JME)

journal homepage: www.jme.shahroodut.ac.ir

THOMSON REUTERS

First Finding of Satin Spar Gemstone in Iran, Folded Zagros Zone, Fars Region

Abbas Zolfaghari*, Nazanin Barzegar and Mohammad Amini

Department of Earth Sciences, Faculty of Sciences, Shiraz University, Shiraz, Iran

Article Info

Received 25 August 2020

Received in Revised form 26 October 2020

Accepted 1 December 2020

Published online 1 December 2020

DOI: 10.22044/jme.2020.9644.1877

Keywords

Satin Spar

Chatoyancy

Gemstone

Zagros Zone

Iran

Abstract

The gypsum mineralization occurred in the form of Satin Spar and Selenite in the south and southwest of the Fars province in the folded Zagros zone. In this region, Satin Spar mineralization has been formed as stratiform between the red marl and siltstone units of Late Miocene–Pliocene in Agha Jari, Bakhtiari, and the Gachsaran formations. The reserves of Satin Spar in this area are at least 200,000 tons. Satin Spar due to its chatoyancy, has been able to distinguish itself from gypsum. This beautiful light phenomenon (chatoyancy) results from the regular and parallel arrangement of the Satin Spar fibers. The mineral was first identified by its physical properties, and then by the X-ray diffraction analysis. They were also examined by scanning electron microscopy for its structure and also the structure of fiber crystals and their optical properties. In order to examine the polishing condition of Satin Spar, several samples of this gemstone were also selected for fantasy and Cabochon cut. For the first time in Iran, the exploration of Satin Spar gemstone in the Fars region can be a model for its discovery in the other evaporative formations in the country.

1. Introduction

Nowadays, in the mining sector, it is very important to have a sufficient and an accurate knowledge on the type of mineral and its applications. The use of a mineral may be limited to a particular industry and market for years due to the lack of sufficient information, and therefore, the value of that mineral is not maintained.

In Iran, the evaporative and clastic formations are widespread. The exploitation of these reserves, regardless of their true value and their principal uses, is, in fact, a form of spoiling mineral resources. For example, the profits of using calcium carbonate (specifically with high purity) in the construction industry are not comparable to those in the pharmaceutical and medical industries. Likewise, the use of calcium sulfate reserves such as gypsum and selenite in the construction industry has a much less revenue and value than the export earnings and its use in the jewelry and artistic industries.

Exploration of the Satin Spar gemstone deposit in the Fars province (Iran) and using it in jewelry is a clear example in explaining such issues, and can pave the path towards the discovery of more deposits of this gemstone in the other parts of the country.

2. Materials and Methods

In order to prospect and identify the Satin Spar gemstone, field surveys were first conducted in several stages, and several samples with different qualities were taken from the exploration area. The samples were first examined based on the physical properties and then analyzed using the X-ray diffraction (XRD) analysis in the central laboratory of the Shiraz University. Besides, in order to examine the cutting and polishing conditions of this gemstone, several samples were selected for fantasy, and cabochon cuttings and making decorative items.

Corresponding author: Zolfaghari.Geo@gmail.com (A. Zolfaghari).

Scanning electron microscopy (SEM) was used to study the structure and arrangement of the Satin Spar fibrous crystals and to find out the cause of the chatoyancy phenomenon (also called the floating radiance) at the central laboratory of the Shiraz University.

3. Discussion

There was no significant plutonism and volcanism activity in the tectono-stratigraphic zone of folded Zagros; therefore, the gemstone deposits are associated with igneous activities, and hydrothermal systems have not yet been reported and explored in these areas [1]. The gemstone resources discovered in the Fars province include the radiolarian cherts in the Nairiz ophiolitic zones, siliceous nodules, some extent Jasper-Agate gemstones in the formations such as the Shurjistan Group [2], and the veins of rutilated quartz in the northeast of the Fars province (Jian Cu deposit) [3].

The folded Zagros zone in the Fars region mainly consists mainly of evaporite, clastic and carbonate formations. In the south and southwest of the Fars province, Satin Spar mineralization has been formed as stratiform between the red marl and siltstone units of Late Miocene–Pliocene in the Agha Jari, Bakhtiari, and Gachsaran formations; gypsum mineralization has occurred in the form of Satin Spar and selenite gemstone. The length of these crystals is more than 150 cm and the width is about 50 cm in the studied area. Below are different types of Satin Spar gemstone with different qualities in the exploration area located in the Fars region (Figure 1).

Then tectonic activities caused faulting and displacement of the layers. Based on the layers shape, the thickness of the layers and their estimated total reserve, the potential resources of the Satin Spar in this area are at least 200,000 tons.

Figure 1. Extraction of Satin Spar mega-crystals, Fars province, exploration area.

4. Satin Spar

In modern usage, Satin Spar is a compact fibrous variety of gypsum. Satin Spar can be cut into very striking chatoyant cabochons. Historically, the name Satin Spar was first applied to a variety of calcites. Other names for the Satin Spar gemstone are namely Seidenspat, Sericolite, Atlas Spar, Plaister Stone, Satin Stone, and Satin Gypsum. The name 'Selenite' is mostly synonymous with gypsum but has been used historically to describe the transparent variety, as opposed to Satin Spar gypsum for the fibrous variety and alabaster for the fine-grained massive form. The original name was given by J.G. Wallerius in his 1747 book "Mineralogia, eller Mineralriket", as 'selenites' [4]. Named from the Greek (σεληνη) the moon, probably from its pale bluish reflections, Selenite is named after the Greek word for the moon, referring to the moonlight effect from cleavage surfaces. Selenite is a variety of gypsum that occurs in transparent crystals or crystalline masses. It is often colorless with a vitreous or pearly luster [5, 6]. The Satin Spar's specific gravity is equal to 2.2 and its hardness is 2. It has a silky and pearly luster, and crystallizes in the monoclinic system [6]. Selenite and Desert rose are also gypsum types that differ from Satin Spar in terms of strength, crystal transparency, and crystalline arrangement. In the definition of a gemstone, hardness, durability, and beauty are important components, but sometimes an optical property and a gemological phenomenon in a mineral can be very significant and place that mineral in the gemstone group [8].

Gypsum cannot be considered as a gemstone due to its low hardness (hardness 2) but the Satin Spar with the same composition and hardness, can be distinguished from gypsum due to the Cat's eye effect [6].

The hand-sample of Satin Spar gemstone is very similar to the Ulexite mineral, a member of Borates when polished; these specimens become the well-known "Television Stone" or "TV Stone". The optical effect exhibited by Television Stone is caused by each one of its individual crystal fibers acting as fiber-optic cables, transmitting light from one surface to the other [7, 8]. Since all the fibers are parallel and compacted together, any image below is transmitted through each crystal fiber to the top surface (Figs. 2 and 3).

For example, texts placed under the stone appear on its surface (Figure 2). Both hand-samples, Satin Spar and Ulexite minerals have almost the same appearance and optical phenomena, and are difficult to distinguish from each other in appearance. However their chemical composition is quite different, there are also differences in the specific gravity and the internal reflection of light in the fibers [9, 10, and 11] (Table1). Figure 3 illustrates these two minerals.

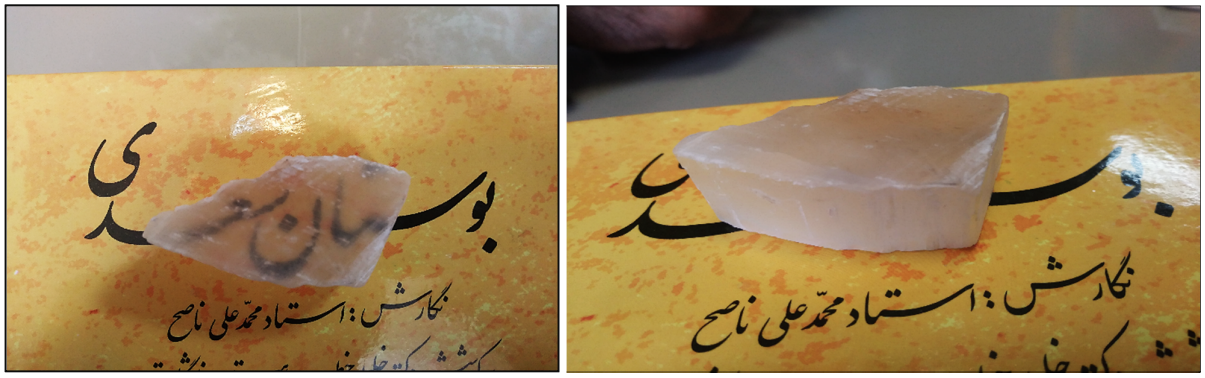

Figure 2. Satin Spar crystals from Iran. Different optical properties in two directions crystals.

Table 1. Satin Spar *vs.* Ulexite [9]

Satin Spar	Ulexite
Print underneath gets blurry at even slight angles	Print underneath is visible at angles up to 30°
Not quite so low specific gravity (2.2)	Very low specific gravity (1.95)
Clearer but sometimes has cracks	Small whitish, brownish, blackish inclusions
View through side of 1" specimen is translucent	View through side of 1" specimen is mostly opaque

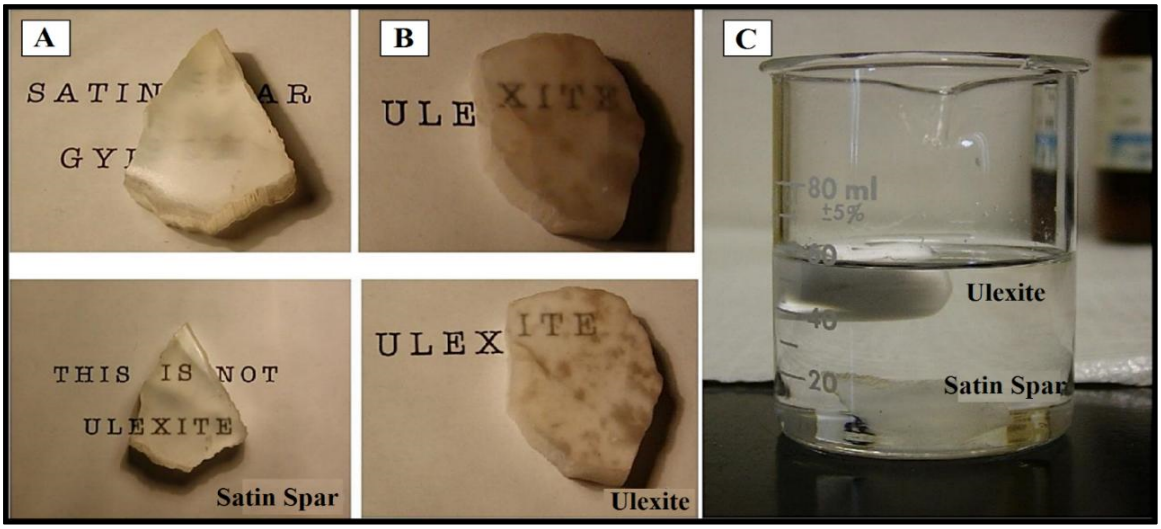

Figure 3. A. Cross-sections of Satin Spar and B. Ulexite viewed at a 20° angle C. Satin Spar sinking and Ulexite floating in a liquid of specific gravity 2.1 (created by mixing bromoform with methylene chloride).

In the present work, the Satin Spar gemstone was first identified on the basis of its physical properties in the field studies, and then it was analyzed using the X-ray powder diffraction method (Figure 4). The chatoyancy phenomenon caused by the regular and parallel arrangement of Satin Spar fiber crystals was investigated by SEM in two directions, one perpendicular to the fibers (cross cutting) and the other parallel to the fibers (parallel cutting). The Cat's eye effect occurs only in the parallel cutting (Figure 5).

The chatoyancy is not observed in the cross cutting but in this condition, the crystals act as fiber-optic cables and any image below is transmitted through each crystal fiber to the top surface (Figs. 6 and 7).

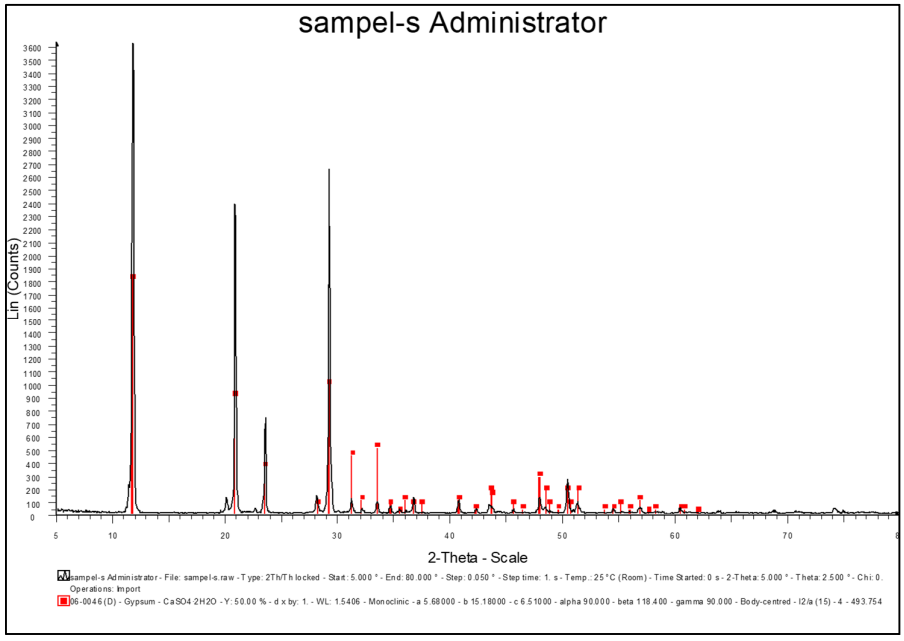

Figure 4. XRD peak from Satin Spar minerals (shown as gypsum) in the Fars region.

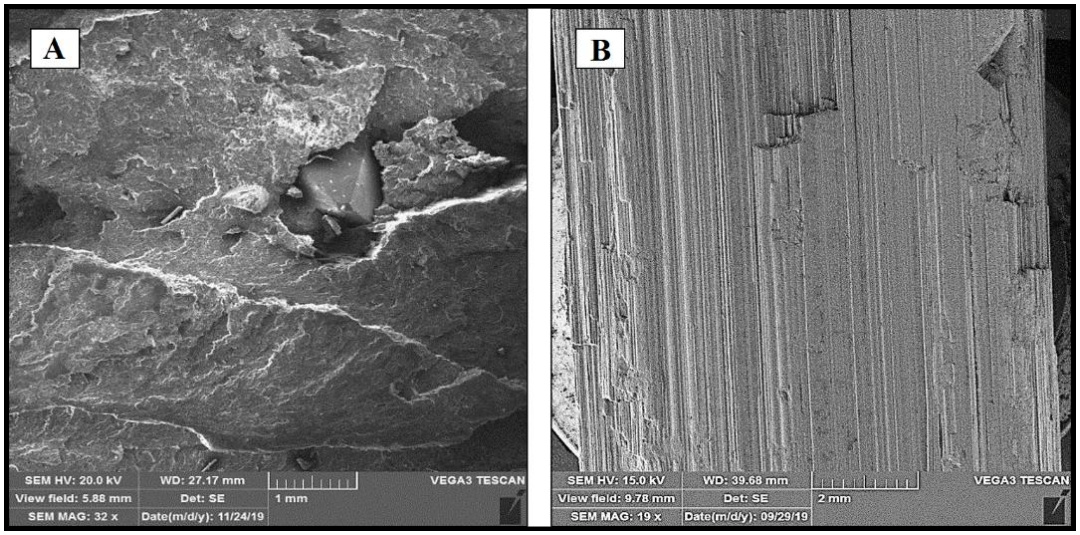

Figure 5. SEM images of Satin Spar samples from the Fars region. A- Cross-section of the Satin Spar crystals (magnification ×32) B- The fibrous structure of the Satin Spar crystals with parallel arrangement (magnification ×19).

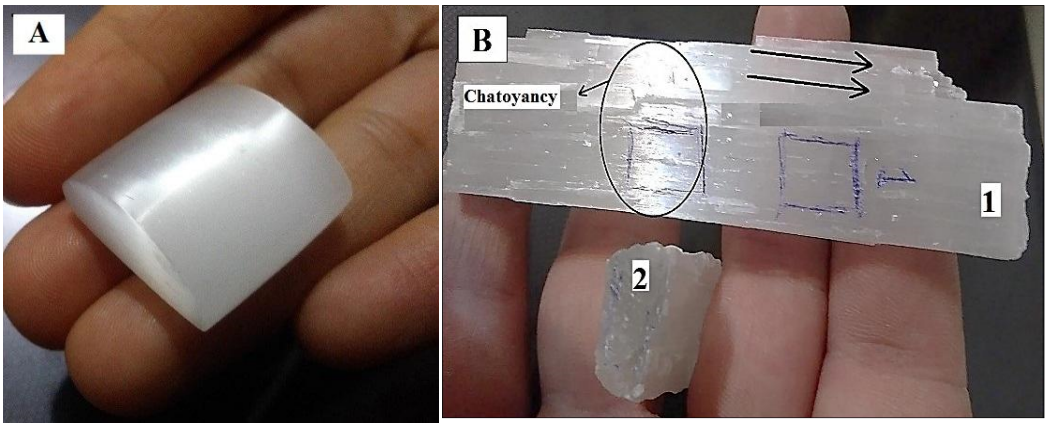

Figure 6. A- Cabochon cut (baguette cut) of Satin Spar with Cat's eye effect B- Investigation of the Cat's eye effect in two directions of fibers.

Figure 7. The Cat's eye effect in the Satin Spar rough samples in the Fars region.

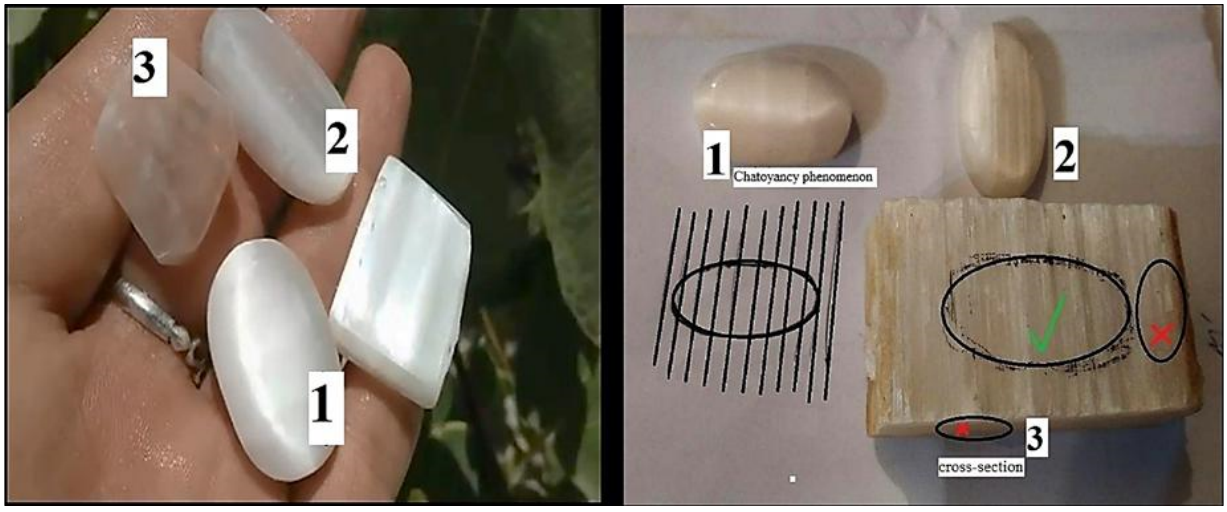

Figure 8. Types of Satin Spar cuts in different directions (samples of Fars region).

Thus in order to investigate the polishing and cutting of the Satin Spar crystals in the discovery region, several examples of this gemstone were selected for the cabochon, fantasy, and carving cuts. For example, if one cuts the long diameter of an oval perpendicular to the Satin Spar fibers, the cat-eye phenomenon appears at its maximum (Figure 8, part 1). Now, if the long diameter of the oval is in the same direction as the Satin Spar fibers, 50% of the cat's eye phenomenon appears (Figure 8, part 2), and if cutting is done in the cross section of the crystals, these gemstones are transparent, and they lack chatoyancy (Figure 8, part 3).

Other applications of this gemstone include its use in gem therapy, meditation, and engraves, making a variety of decorative objects, and also used in a variety of lapidarian methods (Figures 9 and 10).

Figure 9. Cabochon and fantasy cuts and decorative products of Satin Spar gemstone from the Fars region.

Figure 10. Carving cut of the Satin Spar gemstone from the Fars region.

5. Conclusions

The Satin Spar gemstone, due to its chatoyancy phenomenon (cat's eye effect), has been able to distinguish itself from gypsum. This beautiful light phenomenon (chatoyancy) that results from the regular and parallel arrangement of the Satin Spar fibers has made this mineral a favorite.

For the first time in Iran, exploration of the Satin spar gemstone in the Fars region can be a model for its discovery in other evaporative formations in the country, and also provides raw materials for the market and workshops of gemstone-related products in the eastern Asian countries like China, India, and Thailand. Also by constructing the gemstone workshops and using the simplest tools to produce all kinds of lapidarian products and decorative objects related to this gemstone, permanent employment will be created in the country.

Another point is that the required quantities of this mineral for gemstone uses are much less compared to the other industrial uses, and these have lower extraction costs. Therefore, it prevents its widespread sale of raw materials for other uses. Exporting this mineral as a gemstone will bring more income and currency to the country.

References

[1]. MacQillan, H., 1975, Geological compilation map of Kharg - Ganaveh - Kazerun: Tehran, Geological and Exploration Division, No. 30688, 1: 250000, sheet No. 20512.

[2]. Aghanbati, A. (2006). Geology of Iran, Publications of Geological Survey of Iran, p. 586.

[3]. Moore, F., Asadi, S., Fattahi, N. (2011). Geochemistry and Geometry of the Jian Cu deposit (Bavanat), Sanandaj-Sirjan Zone, Northeast of Fars Province, Journal of Advanced Applied Geology, No. 1, p. 80 - 92.

[4]. Wallerius, J.G. (1747). Mineralogia, eller Mineralriket. Stockholm: 50.

[5]. Arthur, Thomas. (2009). Gemstones: New Holland Publishers (UK) Ltd, p. 134, ISBN: 978-1-84773-484-6.

[6]. Michael O'Donoghue. (2006). Gems, Sixth edition, p 378, Elsevier, and ISBN: 978-0-75-065856-0.

[7]. Schumann, Walter. (2001). Gemstones of the world, p 202, Publisher: Robert Hale Ltd. ISBN: 0-7198-0301-2.

[8]. Michael Stevens. (2018). seeing through Selenite, the education YouTube channel Vsauce.

[9]. Shallit.J and Russell.P. (2004). Department of Earth Sciences, University of Waterloo, Ontario N2L 3G1, Canada.

[10]. Dana, J.D. (1850). System of Mineralogy, 3rd. Edition, and New York: 217 (as Hayesine), 695.

[11]. Ulrich Henn and Claudio C. Milisenda. (2004). Gemmological Tables, P. 3, German Gemmological Association, and ISBN: 3-932515-44-7.

اکتشاف گوهرسنگ ساتین‌اسپار برای اولین بار در ایران، زون زاگرس چین خورده، منطقه فارس

عباس ذوالفقاری*، نازنین برزگر و محمد امینی

۱- کارشناسی ارشد زمین شناسی اقتصادی، دانشگاه شیراز، ایران

ارسال۲۰۲۰/۰۸/۲۵، پذیرش ۲۰۲۰/۱۲/۰۱

* نویسنده مسئول مکاتبات: Zolfaghari.Geo@gmail.com

چکیده:

در زون زاگرس چین‌خورده در مناطق جنوب و جنوب‌غرب استان فارس کانی سازی ژیپس در قالب گوهر سنگ ساتین‌اسپار و سلنیت رخ داده است. گوهر سنگ ساتین اسپار در این منطقه به صورت لایه ای و استراتیفرم در بین واحدهای مارنی به سن میوسن پسین و پلیوسن در سازندهای آغاجاری، بختیاری و گچساران تشکیل شده است. ذخیره ساتین اسپار در این منطقه حداقل ۲۰۰۰۰۰ تن برآورد شده است. کانی ساتین‌اسپار، به علت دارا بودن پدیده نوری چشم‌گربه و یا به تعبیری درخشش شناور توانسته است از ژیپس متمایز گردد. این پدیده نوری زیبا که ناشی از آرایش منظم و موازی فیبرهای ساتین‌اسپار است، این کانی را در دنیا به عنوان یک گوهرسنگ محبوب معرفی کرده است. در پژوهش حاضر شناسایی این کانی نخست بر اساس ویژگی های فیزیکی و سپس با استفاده تجزیه به روش پراش پرتوی اشعه ایکس صورت پذیرفت. هچنین با استفاده از میکروسکوپ الکترونی روبشی، آرایش و ساختار بلورهای فیبری و خواص نوری آن مورد بررسی قرار گرفت. با هدف بررسی وضعیت تراش و پالیش پذیری ساتین اسپار، چندین نمونه از این گوهر سنگ نیز برای تراش فانتزی و ساخت وسایل تزئینی انتخاب گردید. اکتشاف گوهرسنگ ساتین‌اسپار برای اولین بار در ایران در منطقه فارس می‌تواند الگویی برای اکتشاف آن در سایر سازندهای تبخیری کشور باشد.

کلمات کلیدی: ساتین اسپار، کتوبانسی، گوهرسنگ، زون زاگرس، ایران.