

Geology of Martian Surface using Satellite Data Available & hence its comparison w.r.t Earth

¹Yamini Malhotra (Corresponding Author), ²SR Singara Subramanian

Research Scholar¹, Professor²

^{1,2}Dept of Earth Sciences, Annamalai University, Annamalai Nagar, Tamil Nadu, India

Abstract: It is analysed that the MATONMADH region of Kutch, Gujarat in India has almost the same lithological features as jarosite on the 'Red Planet' of Mars, magnesium, calcium, aluminium and silicon with hydrous ferrous sulphate. It is also estimated that the mighty rocks of the Martian crust are the richest sources of iron. If the Deccan Volcanic Province / Bhuj / Kutch region is considered to be the twin of Mars, then it should also contain powerful rock rich in uranium and thorium if discovered globally in future. Therefore, the purpose of this study is to find out the relationship between Earth and Mars' mineral stone and water, desert site (Geology and Mars Studies MCC, MOM Immersed photos and information circulated by ISSDC, ISRO).

Keywords- Mars¹, Earth², Kutch³, Pedology⁴, Mineralogy⁵

Introduction- A person weighing 50kg on EARTH would weigh 19kg on Mars!

Planet Mars is more of our Earth than any other planet in the Solar System. In fact, no other world has tickled the human fancy more than our ancient companion, MARS. Despite all of the excitement in recent times over astronauts, exploding galaxies and space stations, it still seems nothing in outer space fires the imagination than the neighbouring body we called as THE RED PLANET.

Why is it termed as THE RED PLANET?

Humans have wondered about the mysteries of the planet Mars since the Babylonians began exploring the skies with astronomy around 400 B.C. To those people in ancient times, Mars looked like a RED STAR passing through the night sky.

The colour 'RED' was associated with 'BLOOD', thus 'DEATH' and 'WAR'. The people of ancient cum medieval times also associated the small reddish 'STAR' like 'ARCTURUS' and 'ANTARES' with the element 'IRON' and Men used Iron weapons to wage war. The Egyptians called it the "RED ONE". The Sumerians, who lived in what we now call the Middle East on the territory of Modern Iraq, pronounced the small RED DOT in the SKY or THE STAR OF DEATH and named it after NERGAL, their GOD OF WAR AND DEATH. From that time, the fourth planet from the SUN has been named for as THE GOD OF WAR. The Greeks referred to it as ARES for their GOD OF WAR while the Romans saw it as an aggressive light in the heavens worthy of the name of their mythical god of war "MARS". That name has lasted. Today too, we refer to MARS as the RED PLANET because it is easily distinguished in the night sky by its reddish colour, that comes from rusty rocks and sand covering the Martian surface. PHOBOS and DEIMOS are the moons of MARS. In Greek Mythology, those were the names of the sons of the GOD OF WAR. The larger moon is PHOBOS, meaning FEAR and the smaller is DEIMOS, meaning PANIC.

Mars doesn't always look red. When viewed from Earth, it changes colour. Say for example, RED COLOUR indicates the SURFACE OF THE PLANET while GOLD infringes THE MAJOR DUST STORM ON THE PLANET. ICE CAPS too were interpreted. MARS looked so much like EARTH. It might be inhabited. Giovanni Schiaparelli's map of Mars compiled over the period 1877- 1886 used names based on the classical geography, as for example MARE AUSTRALE (Southern Sea). Most of these names of place are still in use today.

GLOBAL VIEW OF MARS- Global images of MARS was acquired by MCC: Mars Colour Camera of MOM: Mars Orbiter Mission around Sep/Oct 2014 at a spatial resolution of ~3.5km from an altitude of 6652 km. It shows predominant geological Martian features namely-

GALE CRATER- It is about 3.5 to 3.8 billion years old impact crater and is located below Elysium Planitia region of Mars.

AMAZONIS PLANITIA- It is located between the two main volcanic provinces on MARS namely THARSIS and ELYSIUM. It contains the youngest fluvial deposits and lava flows on the planet.

ELYSIUM MONS- This volcanic province is located at the eastern hemisphere of MARS. It is the second largest volcanic province on MARS.

OLYMPUS MONS- It is the largest volcano in the Solar System which is present on planet MARS. The altitude of Olympus Mons is nearly 3 times the altitude of the largest peak on EARTH, on MOUNT EVEREST.

MARS STATISTICS

MASS (kg)	6.421e+23
MASS (Earth=1)	1.0745e-01
EQUATORIAL RADIUS (km)	3397.2
EQUATORIAL RADIUS (Earth=1)	5.3264e-01
MEAN DENSITY (gm/cm ³)	3.94
MEAN DISTANCE FROM THE SUN (km)	227940000
MEAN DISTANCE FROM THE SUN (Earth=1)	1.5237
ROTATIONAL PERIOD (hours)	24.6229

ROTATIONAL PERIOD (days)	1.025957
ORBITAL PERIOD (days)	686.98
MEAN ORBITAL VELOCITY (km/sec)	24.13
ORBITAL ECCENTRICITY	0.0934
TILT OF AXIS (degrees)	25.19
ORBITAL INCLINATION (degrees)	1.850
EQUATORIAL SURFACE GRAVITY (m/sec ²)	3.72
EQUATORIAL ESCAPE VELOCITY (km/sec)	5.02
VISUAL GEOMETRIC ALBEDO	0.15
MAGNITUDE (V _o)	-2.01
MINIMUM SURFACE TEMPERATURE	-140 degrees C
MEAN SURFACE TEMPERATURE	-63 degrees C
MAXIMUM SURFACE TEMPERATURE	20 degrees C
ATMOSPHERIC PRESSURE (bars)	0.007
ATMOSPHERIC COMPOSITION	
CARBON DIOXIDE (CO ₂)	95.32%
NITROGEN (N ₂)	2.7%
ARGON (Ar)	1.6%
OXYGEN (O ₂)	0.13%
CARBON MONOXIDE (CO)	0.07%
WATER (H ₂ O)	0.03%
NEON (Ne)	0.00025%
KRYPTON (Kr)	0.00003%
XENON (Xe)	0.000008%
OZONE (O ₃)	0.000003%

Table 1- Depicting statistics of MARS, Source: from Mars Encyclopedia

LIST OF TALLEST MOUNTAINS OF EARTH AND MARS:

EARTH-

TALLEST PEAK/s	HEIGHT	RADIUS	ORIGIN	REMARK/s
MAUNA KEA & MAUNA LOA	10.2km	0.16	VOLCANIC	JUST 4.2km OF THIS IS ABOVE SEA LEVEL
PICODEL TEIDE	7.5km	0.12	VOLCANIC	RISES 3.7km ABOVE SEA LEVEL
DENALI	5.3 to 5.9km	0.093	TECTONIC	TALLEST MOUNTAIN BASE TO PEAK ON LAND
MOUNT EVEREST	3.6 to 4.6km	0.072	TECTONIC	4.6km ON NORTH FACE, 3.6km ON SOUTH FACE

Table2: Relating tallest peaks of Earth, Source: from Google Chrome

MARS-

TALLEST PEAK/s	HEIGHT	RADIUS	ORIGIN	REMARK/s
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OLYMPUS MONS	21.9km	0.65	VOLCANIC	RISES 26km ABOVE NORTHERN PLAINS, 1000km AWAY. SUMMIT CALDERAS ARE 60*80km WIDE, UPTO 3.2km DEEP, SCARP AROUND MARGIN IS UPTO 8km
ASCRAEUS MONS	14.9km	0.44	VOLCANIC	TALLEST OF THE THREE THARSIS MONTES
ELYSIUM MONS	12.6km	0.37	VOLCANIC	HIGHEST VOLCANO IN ELYSIUM
ARSIA MONS	11.7km	0.35	VOLCANIC	SUMMIT CALDERAS IS 108 to 138km
PAVONIS MONS	8.4km	0.25	VOLCANIC	SUMMIT CALDERA IS 4.8km
ANSERIS MONS	6.2km	0.18	IMPACT	AMONG THE HIGHEST NONVOLCANIC PEAKS ON MARS, FORMED BY THE HELLAS
AEOLIS MONS (MOUNT SHARP)	4.5 to 5.5km	0.16	DEPOSITIONAL	FORMED FROM DEPOSITS IN GALE CRATER, TO BE ASCENDED BY THE MSL ROVER

Table 3: Mentioning mountains of MARS, Source: Google chrome

MINERALOGY-

Mars is primarily an igneous planet. Rocks in the crust and on the surface consist mainly of minerals that crystallizes from magma. Spectrometers currently in orbit include-

THEMIS (MARS ODYSSEY),
OMEGA (MARS EXPRESS), and
CRISM (MARS RECONNAISSANCE ORBITER)

Mars exploration rovers carry an Alpha Particle X-ray Spectrometer (APXS), a thermal emission spectrometer (MiniTES), and Mossbauer spectrometer to identify minerals on the surface. The results from the rover's CheMin analyzer revealed the presence of several minerals including feldspar, pyroxenes and olivine, and suggested that the Martian soil in the sample was similar to the athered basaltic soils of Hawaiian volcanoes. The dark areas of Mars are characterized by the mafic rock forming minerals like olivine, pyroxene and plagioclase feldspar. These minerals are the primary constituents of basalt, a dark volcanic rock that also makes up the earth's oceanic crust and the LUNAR MARIA. The mineral Olivine occurs all over the planet, but some of the larger concentrations are in Nili Fossae, an area containing Noachian aged rocks. Another large olivine rich outcrop is in Ganges Chasma, an eastern side chasm of Valles Marineris. Olivine weathers rapidly into clay minerals in the presence of liquid water. Therefore, areas with large outcroppings of olivine- bearing rock indicate that liquid water has not been abundant since the rocks formed. Pyroxene minerals are also widespread across the surface. Both low calcium (ortho) and high calcium (clino) pyroxenes are present, with the high calcium varieties associated with younger volcanic shields and the low forms (enstatite) more common in the old highland terrain.

DUST AND SOIL- The red/ orange appearance of the dust is caused by iron (III) oxide (nanophase Fe_2O_3) and the iron (III) oxide-hydroxide mineral goethite.

Secondary (alteration) minerals- Some of the mineral classes detected may have formed in environments suitable (i.e., enough water and the proper pH) for life. The mineral smectite (a phyllosilicate) forms in near neutral waters. Phyllosilicates and Carbonates are good for preserving organic matter, so they may contain evidence of past life. Sulfate deposits preserve chemical and morphological fossils, and fossils of micro-organisms form in iron oxides like hematite. The presence of opaline silica points towards a hydrothermal environment that could support life. Silica is too suitable for preserving evidence on microbes.

GENERAL FEATURE OF MARS with respect to EARTH-

FEATURES	MARS	EARTH
ATMOSPHERE(Composition)	CO ₂ (95.32%)	NITROGEN (77%)
	NITROGEN (2.7%)	OXYGEN (21%)
	ARGON (1.6%)	ARGON (1%)
	OXYGEN (0.13%)	CO ₂ (0.038%)
	WATER VAPOUR (0.03%)	
	NITRIC OXIDE (0.01%)	
ATMOSPHERE(Pressure)	7.5 MILLIBARS (average)	1,013 MILLIBARS (AT SEA LEVEL)
DEEPEST CANYON	VALLIS MARINERIS 7km DEEP, 4000km WIDE	GRAND CANYON 1.8km DEEP, 400km LONG
DISTANCE FROM SUN (average)	227,936,637km	149,597,891km
EQUATORIAL RADIUS	3,397km	6,378km
GRAVITY	0.375 that of EARTH	2.66 times that of MARS
LARGEST VOLCANO	OLYMPUS MONS 26km (16 MILES) HIGH, 602km IN DIAMETER	MAUNA LOA (HAWAII) 6.3 MILES HIGH, 121km IN DIAMETER
LENGTH OF DAY (Time required to make a full rotation on its axis)	24 hrs 37 min	JUST SLIGHTLY under 24 hrs
LENGTH OF YEAR (Time required to make a complete orbit of the Sun)	687 EARTH DAYS	365 DAYS
POLAR CAPS	Covered with a mixture of CO ₂ ICE & WATER ICE	Permanently covered with WATER ICE
SURFACE TEMPERATURE (average)	-81 degrees F (-63 degrees C)	57 degrees F (14 degrees C)
Tilt of Axis	25 degrees	23.45 degrees
NO. of SATELLITES	2 (PHOBOS & DEIMOS)	1 (MOON)

Table 4: Comparison between Earth and Mars via geographical features, Source: Google Chrome

ABOUT MOM – The Mars Orbiter Mission (MOM) also called as Mangalyaan is a space probe orbiting Mars since September 24, 2014. It was launched on November 5, 2013 by the Indian Space Research Organization (ISRO). It is India’s first interplanetary mission and ISRO has become the fourth space agency to reach MARS after the Soviet Space Program, NASA and the European State Agency. It is the first Asian nation to reach Mars orbit and the first nation in the world to do so in its first attempt. MISSION MANGAL is the Indian Documentary movie on its journey from scratch to success. The Mars Orbiter Mission probe lifted-off from the First Launch Pad at Satish Dhawan Space Centre (Sriharikota Range SHAR), Andhra Pradesh using a Polar Satellite Launch Vehicle (PSLV) rocket C25 at 09:08 UTC on November 5, 2013. The launch window was approximately 20 days long and started on October 28, 2013. The MOM probe spent about a month in Earth’s orbit, where it made a series of seven apogee- raising orbital manoeuvres before trans- Mars injection on November 30, 2013 (UTC). After a 298- day transit to Mars, it was successfully inserted into Mars orbit on September 24, 2014. The mission is a technology demonstrator project to develop the technologies for designing, planning, management, and operations of an interplanetary mission. It carried five instruments that helped in advance knowledge about Mars to achieve its secondary -scientific objective. The spacecraft was monitored by the Spacecraft Control Centre at ISRO Telemetry, Tracking and Command Network (ISTRAC) in Bangalore with support from Indian Deep Space Network (IDSN) antennae at Byalalu.

SCIENTIFIC INSTRUMENTS/ PAYLOADS-

1. LAP	Lyman-Alpha Photometer	1.97 kg
2. MSM	Methane Sensor for Mars	2.94 kg
3. MENCA	Mars Exospheric Neutral Composition Analyzer	3.56 kg
4. TIS	Thermal Infrared Imaging Spectrometer	3.20 kg
5. MCC	Mars Color Camera	1.27 kg

Table 5: Stating payloads used for sending rovers on Mars, Source: Space Encyclopedia

Based on the insitu data via Remote Sensing, the most abundant chemical elements in the martian crust, besides silicon and oxygen are iron, magnesium, aluminium, calcium and potassium. These elements are major components of the minerals comprising igneous rocks. Hydrogen is present as water (H₂O) ice and in hydrated minerals. Carbon occurs as Carbon Dioxide (CO₂) in the atmosphere and sometimes as dry ice at the poles. An unknown amount of carbon is also stored in carbonates. Molecular nitrogen (N₂) makes up 2.7% of the atmosphere.

KUTCH-

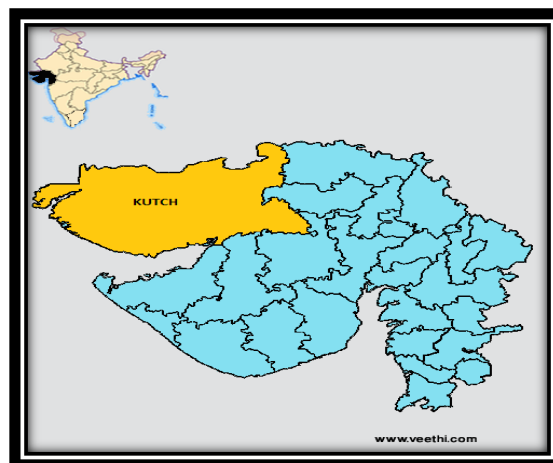


Figure 1: Indian Kachhh/ Kutch region map of Gujarat

Kutch means something that intermittently becomes wet and dry. A large part of this district is known as RANN of KUTCH which is swallowed wetland which submerges into water during rainy season and becomes dry during other seasons. In Sanskrit, Kutch means a TORTOISE. The RANN is famous for its marshy salt flats which became snow white after the swallow. Water dries up each season before the monsoon rains. Kutch district is surrounded by the Gulf of Kutch and the Arabian Sea in south and west, while northern and eastern parts are surrounded by the Great and Little RANN (Seasonal wetlands) of Kutch. There are around 97 small rivers in Kutch district. Most of which flow into the Arabian Sea, but some of which feed the RANN of KUTCH. Kutch is mineral rich region with very large reserve of Lignite, Bauxite, Gypsum and etc. among other minerals. Kutch district has a scanty forest cover. Hence, there is negligible risk of illegal cutting of forests. The little Rann of Kutch is known for Traditional Salt production and various references mention this to be a 600-year-old activity.

BETWEEN KUTCH AND MARS- Recent studies has shown the presence of jarosite $[K_2Fe_3(SO_4)_2(OH)_6]$, a potassium bearing hydrous iron-sulphate on Mars has Astro-biological implications. Keeping in view of that, spectroscopic and geochemical analysis of hydrous sulphates study has been conducted by SAC in 2012 from the DECCAN VOLCANIC PROVINCE (DVP) of Kutch, Gujarat. MATONMADH area of Kutch represents the westernmost part of DVP and is mainly characterized by continental flood basalts of plume region and hydrous sulphates of secondary origin. DVP of Kutch, therefore, could be considered as a potential analogue site in order to get insights into the hydrous sulphate related aqueous alteration processes on the Mars.

CONCLUSION- It is concluded that globally on a hunt for Mars Mineralogical Lithology, maybe Kachchh of Gujarat, India is having little resemblance which infringes one can collect rock samples from MATONMADH of KACHCHH region for further evaluation in Mars research and testing.

Declaration- FUNDING AND/OR CONFLICT OF INTEREST-

There is no conflict of interest so defined. As of now, no funding is provided by any funding agency.

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