

Rare earth elements in Iran And Case study for Gazestan deposit

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Guidelines

- Introduction of REEs Exploration in Iran
- Gazestan deposit location
- General geology
- Body ore estimation
- Iran Mineral Processing Research Centre (IMPRC)
- Summary of processing study
- Conclusion

Introduction of REEs Exploration in Iran

- Resources of REEs are distributed in Iran which main one is located in central- Iran.
- REEs resources in Iran are generally detected in phosphate rocks and iron ore reserves which they can be extracted as by-products
- In central Iran, REEs is associated with apatite mineralization .

Introduction of REEs Exploration in Iran

- Maximum grade of REEs in these resources are about 0.5 % which are light REEs .
- Recently, exploration studies has been done on east- north Iran and shows the existence of huge REEs reserves .

Location of Gazestan deposit

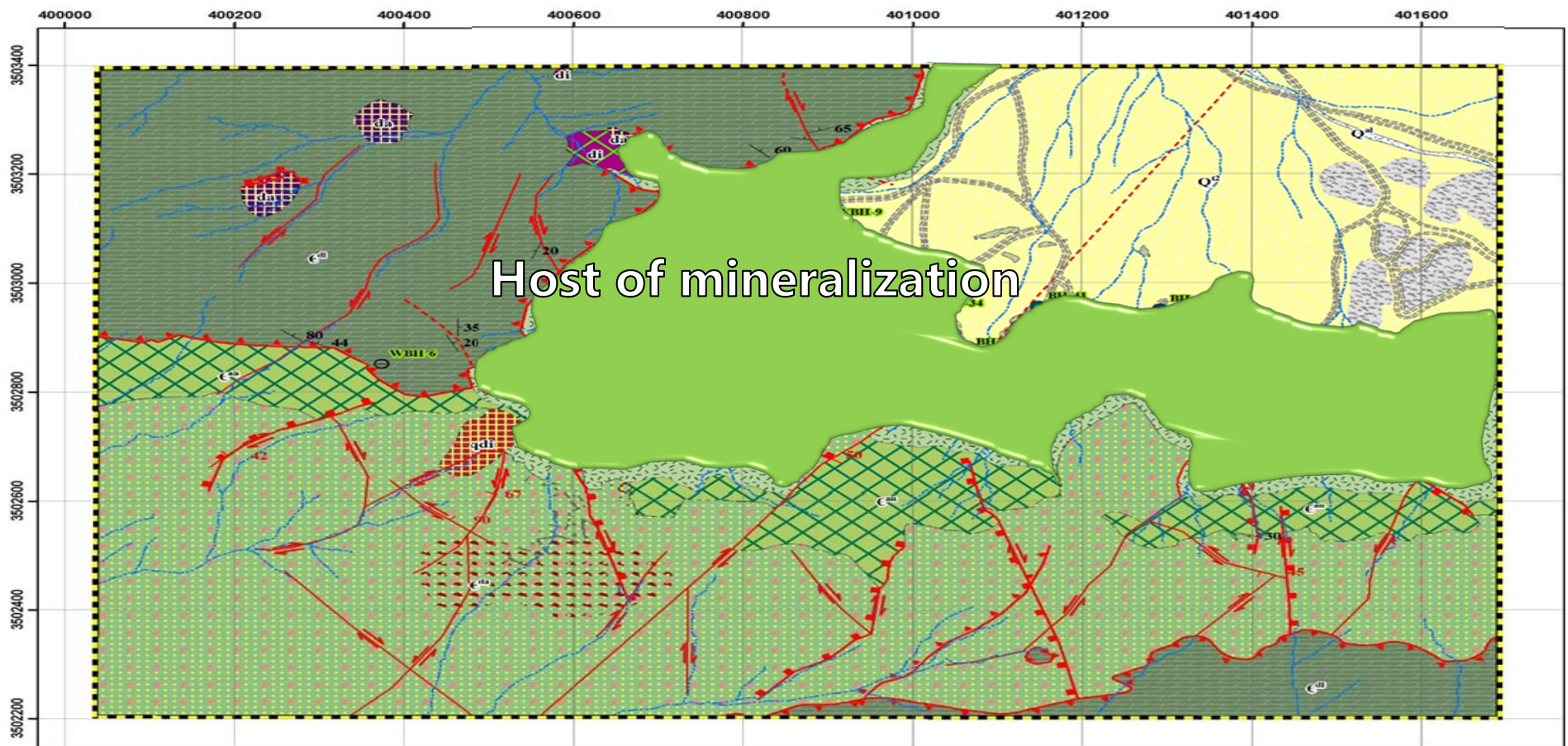


Gazestan deposit is located in 78 km east of Bafgh which belongs to central-Iran zone of Iran's structural zones



Main rocks in this area are related to Precambrian to Cambrian Rizo Series which include:

- ✓ **sedimentary units** such as Shale, Sandstone, Carbonate
- ✓ **volcanic and plutonic rocks** such as Metasomatized Basalt, Andesit basalt, Diorite, Dasit.
- ✓ **Metasomatic rocks** are host of mineralization in this area.



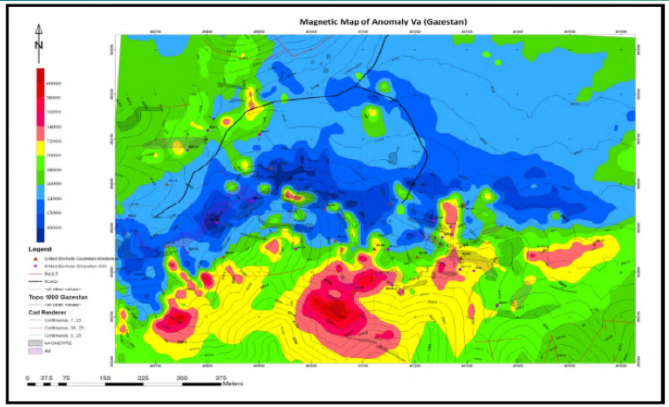
Body ore estimation

To do complete exploration operation, comprehensive measures were carried out including:

- Topographic, geologic, and magnetometer maps preparation and drilled boreholes (6133m) which are used for REEs exploration in Gazestan deposit.
- Obtained samples of the boreholes were sent for XRD, XRF, ICP and AAS analyses in this study
- Totally, gotten data are used for body ore modelling and estimation

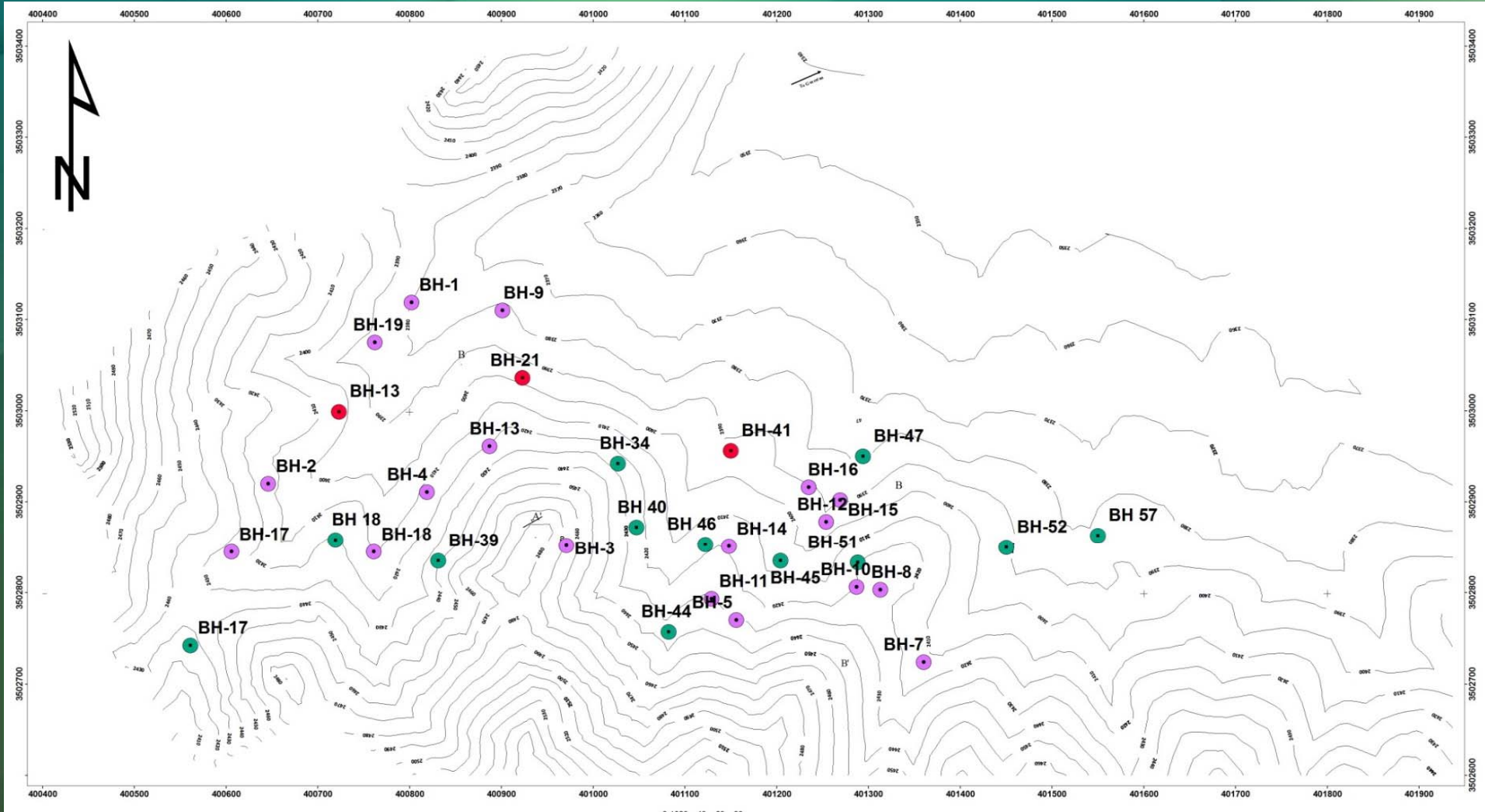
Magnetic map of Gazestan

Magnetic enrichment is occurred in the boundary of red & blue zones contacts



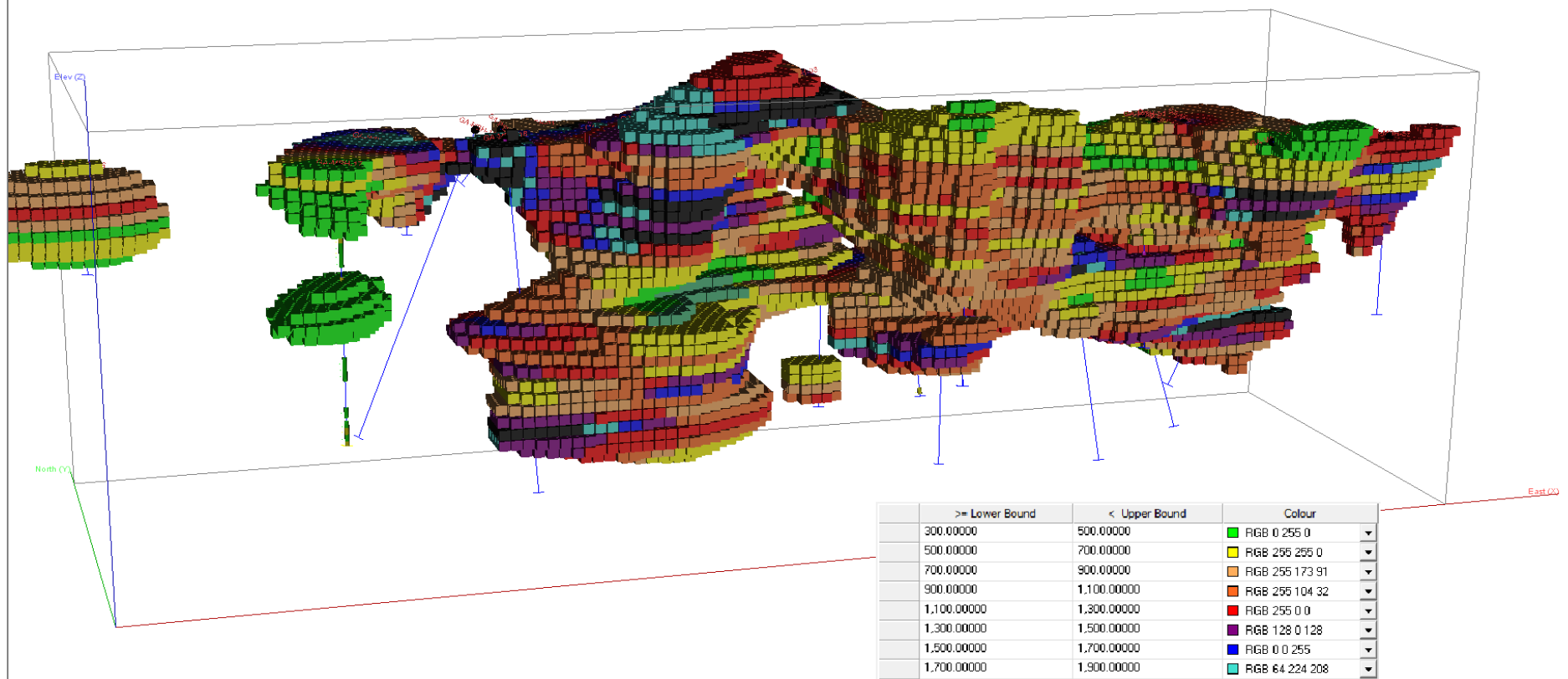
Drilling Locations in Gazestan

34 boreholes have been drilled and sampled for XRD, XRF, ICP and AAS analyses in this study



REEs block model of Gazestan deposit

- According to the type of deposit and the amount of obtained exploration data, IDS model standing for the inverse distance squared used for resources estimation.
- In conclusion, the deposit tonnage **is about 60Mt**
- The grades of Fe, P and TREEs are 26%, 2% and 0.1 %, respectively.



Introduction of IMPRC

Iran Mineral Processing Research Center (IMPRC), subsidiary of the Ministry of Industries & Mines of Iran is located in 60 km west of Tehran (capital of Iran).

- In IMPRC many Researches are done on the mineral beneficiation of the vast variety of the ore types which started it's work in 2004.

This center Consists of 4 departments:

- Mineral processing in Lab. & Pilot scales
- Chemical lab.
- Environmental Lab.
- Mineralogical Lab.



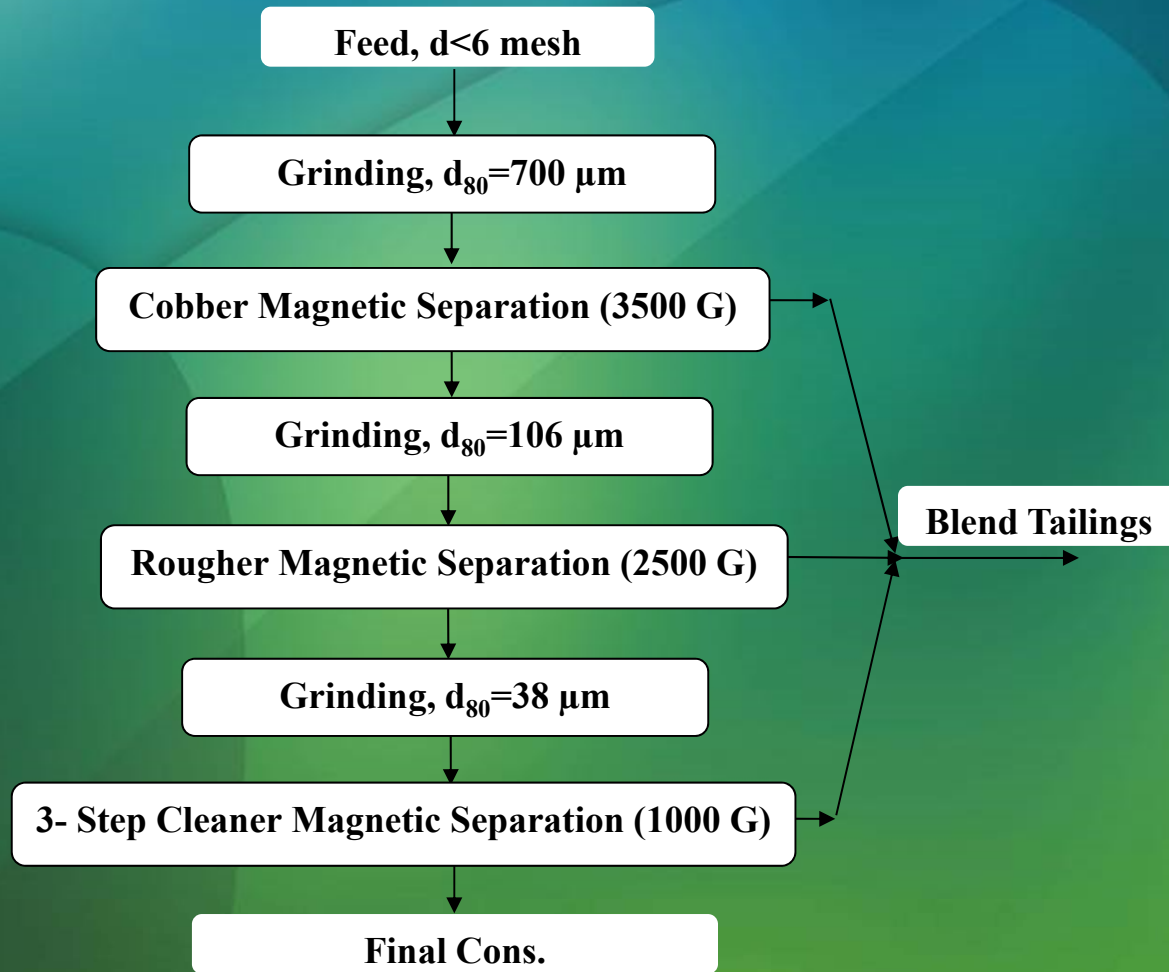
Gazestan ore representative sample

- ✓ Before doing any beneficiation study, head sample preparation is essential.
- ✓ Accordingly, based on block model, Gazestan representative sample was prepared.

Representative sample characteristics	
Fe (%)	25.58
TREEs (ppm)	965.21
P (%)	0.5

- ✓ Based on chemical analyses and Lithology study, it was supposed to do magnetic and gravity separations to produce suitable products of Iron and REEs concentrations
- ✓ The REEs concentrate was led to hydrometallurgical study

Magnetic Separation Flow- sheet on laboratory scale



Total REEs recovery obtained 96.44%

Magnetic Separation Products

✓ REEs concentrate

Non-Magnetic Product	
Blend of Cobber, Rougher, and 1st Cleaner steps Tailings	
Fe (%) in Blend Tail.	9.8
TREEs in Blend Tail (ppm)	1661.33
TREEs Recovery (%)	96.44

✓ Iron concentrate (By-product)

Final Magnetic Product, (Iron Concentrate)	
TFe Recovery (%)	74.27
Fe (%) in Mag. Product	67.12
TREEs (ppm) in Mag. Product	121.3



Mag. Sep. Tailings

Mag. Sep.
Concentrate

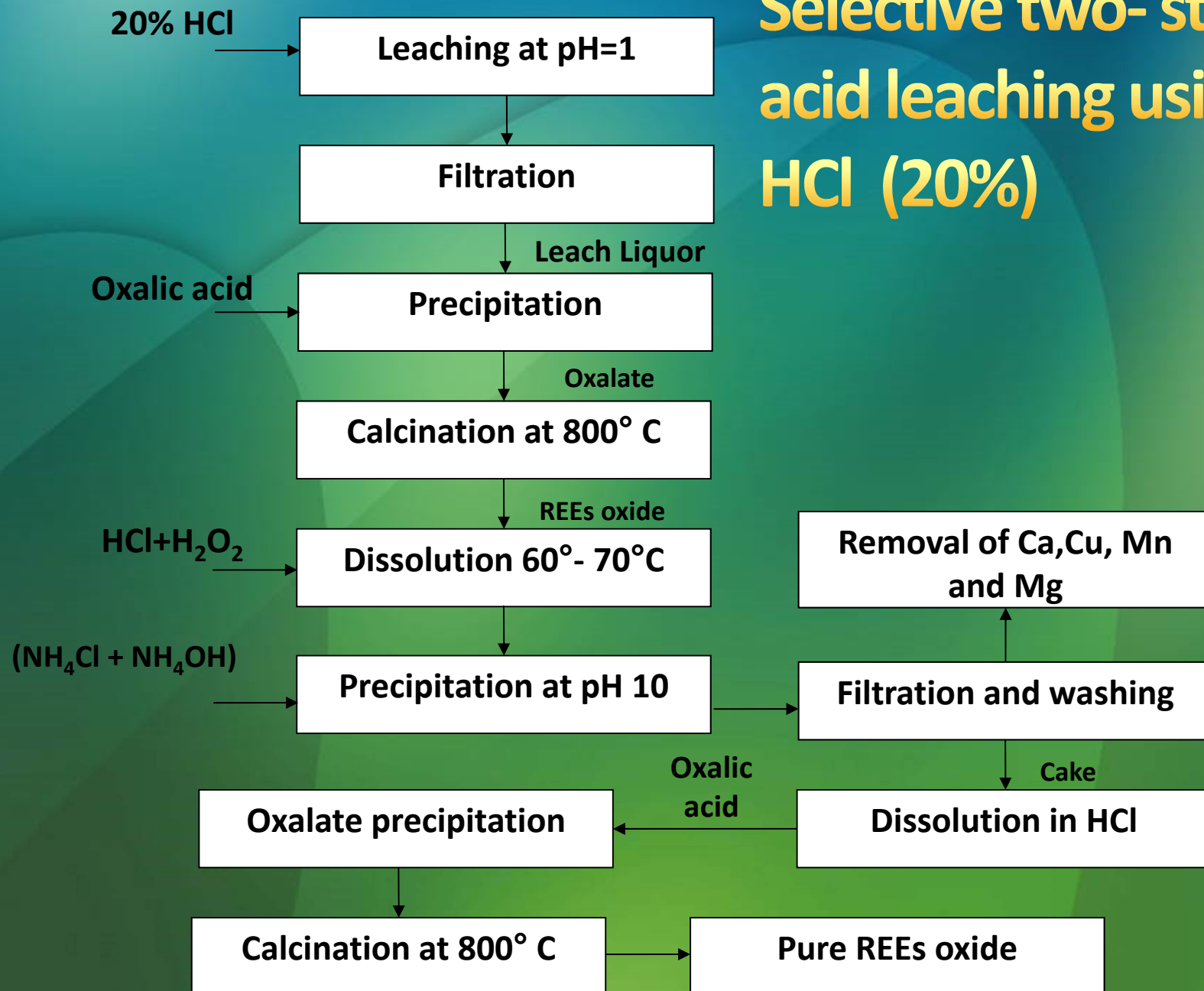
Hydrometallurgical study

For Hydrometallurgical study, three methods have been selected including:

- ✓ Acid roasting
- ✓ Alkali cracking
- ✓ Acid leaching
 - Selective acid leaching using sulphuric acid (20%)
 - Selective acid leaching using HCl (20%)
 - Selective two- step acid leaching using HCl (20%)

- Among these experimental methods, **selective two- step acid leaching using HCl (20%)** concluded best results and pure REEs are obtained

Selective two-step acid leaching using HCl (20%)



Selective two- step acid leaching using HCl (20%)

A technically feasible process has been developed from Gazestan ore tailing powder containing 0.14% rare earths. The purity and recovery of the product are >95% and 90 % respectively.

**Acid leaching
product**



Conclusion

- Mineralization of deposit includes of iron minerals and apatite with minor quartz and calcite which occurs as various forms mainly in green rocks and rarely in rhyolite. Apatite is Fluorapatite and content of Cl is very low.
- Monazite is the main mineral of Gazestan that has been concentrated in Apatite and Quarts.
- Based on assessments and simulation by mining software, the deposit tonnage of ore bodies is about 60Mt. The grades of Fe, P and TREEs are 26%, 2%, 0.1 %, respectively.

Conclusion

- The beneficiation studies on a representative sample have been carried out in the lab scale. By operating magnetic separation flowsheet, it is possible to produce a proper magnetic product containing about 67% Fe. Then Non-magnetic fraction with TREEs recovery of 96%, was led to hydrometallurgical study
- Three main hydrometallurgical methods are tried for REEs extraction. Among them, selective acid leaching using HCl was chosen.
- By applying Acid leaching in two steps, it could be possible to remove all impurities and obtain pure REEs (95%) with the recovery of 90%.

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**Many thanks for your kindly
attention**