

# Prehistory of an enigmatic mineral: hisingerite

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## ABSTRACT

According to most sources, the type locality for the hydrous iron silicate mineral hisingerite is Riddarhyttan, Västmanland, Sweden, first reported in 1828. However, it was described by A.F. Cronstedt as early as 1751 from Väster Silvberg, Dalarna (under the name “kolspeglande järnmalm”), and in 1810 by W. Hisinger from the Gillinge iron mine, Södermanland (“svart stenart”, later “gillingit”). J. Berzelius introduced the presently valid species name (originally spelt “hisingrit”) in 1819. Potential type materials are preserved by the Swedish Museum of Natural History, from Gillinge and Riddarhyttan. A Hisinger specimen from Gillinge has recently been analysed and was shown to contain associated potassic-hastingsite, magnetite and fayalite that explain the previously observed aluminium contents and high density for “gillingit”, compared to pure hisingerite.

## ARTICLE HISTORY

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A mineral species is defined by its chemical and structural properties (Hawthorne et al. 2021). Essential components of a mineral description are the name given to the species and the assignment of the type specimen(s) on which the original determination is based. Sometimes, the discovery history of a mineral is not straightforward but includes a timeline of different names and localities. The purpose of the present note is to call attention to the earliest descriptions of hisingerite, which have largely been overlooked (Table 1).

Hisingerite most often occurs as a secondary mineral, formed from the decomposition or late-stage hydrous alteration of iron-bearing silicates or sulphides. It is normally not rock-forming but quite widespread globally (e.g., Mustoe 1996) and has been inferred to be a component of Martian sediments (e.g., Treiman et al. 2016). It is poorly crystalline (or nanocrystalline) and this fact has prevented structure determinations by conventional diffraction methods. Speculations on the nature of this mineral on the atomic level were frequent in the twentieth century. According to present knowledge, it is a phyllosilicate closely related to the kaolinite group of minerals (Eggelton & Tilley 1998; Brigatti et al. 2013), and the ideal chemical formula could be given as  $\text{Fe}_2\text{Si}_2\text{O}_5 \cdot (\text{OH})_4 \cdot 2\text{H}_2\text{O}$ .

## Discovery history of hisingerite

In a short paper of seven pages, in Swedish, Cronstedt (1751) reported three new minerals. Two of them were recognised early and correspond to cerite-(Ce) and scheelite, which came to have significant importance for the scientific characterisation of the metals cerium and tungsten, respectively, in the following decades (Engström 2008). The third one, which

was given the name “*kol-speglende järnmalm*” (“coal-mirroring iron ore”) by him, appears not to have made an impression on following generations of mineralogists. It appears enclosed in “*derb lefver-färgad kjes*” (coarse liver-coloured pyrite = pyrite or pyrrhotite) from Spakgruvan, Väster Silvberg, Dalarna, and is described as follows: “*Färgen var svart, texturen tät och glänsande, brottet föll likt med flint-arterne, antingen i convexa eller concave ytor, och hela utseende liknar så noga bärgbeck eller de täta stenkolen, at den bästa kännare kunde i hastighet förtaga sig derpå.*” [The colour was black, the texture dense and shiny, the fracture appeared the same as that of the flints, with either convex or concave surfaces, and the whole appearance so closely resembles bitumen or dense coal, that even the best expert could make a mistake in haste.] Further on, he described the mineral as being soft and having a low density; it is not affected by solvents, and it does not bear a static electricity (in contrast to bitumen). It does not burn in the furnace, but loses 1/5 of its weight when heated and becomes magnetic. When reduced, iron metal plus slag is obtained. Notably, he grouped the mineral with the ochres (i.e., ferric oxides mixed with silicate). He finally mentioned another locality for a possibly similar substance, Viks koppargruva, Garpenberg, Dalarna.

From the information provided, it is clear that the new mineral is hisingerite, but Cronstedt’s description seemingly went unnoticed and is therefore not referred to in later works. For unknown reasons, it was not mentioned in his own mineral classification system (Cronstedt 1758) either. The next known record of the species was by Hisinger (1810), who described a similar material, “*en svart stenart*” (a black kind of stone), from the Gillinge iron mine in Södermanland, presenting its physical properties in more detail, including a

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**Table 1.** Names given to hisingerite, and the early localities of discovery.

Name	Locality	Reference
kol-speglande järnmalm	Spakgruvan	Cronstedt (1751)
svart stenart	Gillinge	Hisinger (1810)
silicias ferroso-aluminicus	Gillinge	Berzelius (1814)
hisingrit	Gillinge	Berzelius (1819)
gillingit	Gillinge	Hisinger (1826)
hisingerit	Riddarhyttan	Hisinger (1828)

numeric value for the density,  $3.04 \text{ g/cm}^3$  (noted as high compared to later studies that indicate a range of 2.4–2.7 for hisingerite). His report contains the first wet chemical analysis of the mineral, giving  $\text{SiO}_2$  and  $\text{Fe}_2\text{O}_3$  as the main components, with some additional  $\text{Al}_2\text{O}_3$ . Berzelius (1814), in the original, Swedish edition of his mineral classification system, in the 13th order of the family *Ferrum*, the *Silicates*, termed the mineral “*silicias ferroso-aluminicus*”, with a reference to Hisinger’s analysis.

Hisingerite was then mentioned under the name “hisingrit” by Berzelius (1819) in a systematic listing of minerals in the French edition of his system, where he put it in the third order (electropositive metals) among combustible bodies, second subdivision (metals which are not reducible with carbon and whose oxides form earths and alkalis), second family (*aluminium; silicates à bas double*). Hisinger (1819) referred to this publication and repeated the data from his original investigation (Hisinger 1810). Afterwards, he introduced a new name, “gillingit”, for the same mineral from Gillinge (Hisinger 1826).

In a later publication, Hisinger (1828) reported a second occurrence of hisingerite, under the name “Hisingerit”, from Riddarhyttan, Västmanland, and gave an accurate chemical analysis of the material:  $\text{SiO}_2$  36.3  $\text{Fe}_2\text{O}_3$  44.4  $\text{H}_2\text{O}$  20.7 (all in wt.-%; compared with the “ideal” values from the accepted nominal formula: 34.2, 45.4, 20.5). This was the first description of hisingerite in a major language (German) journal,

and consequently, it is the work that most standard sources refer to regarding the type locality of hisingerite (e.g., Clark 1993; [www.mindat.org](http://www.mindat.org)).

In his textbook on the use of blowpipe analysis in chemistry and mineralogy (the second German edition), Berzelius (1828) finally grouped the minerals from the two localities, Gillinge and Riddarhyttan, together. Thereafter, Berzelius (1829) summarised the state of knowledge and mentioned additional localities in Sweden and abroad, and for the first time explicitly stated that the mineral was named in honour of Wilhelm Hisinger (but still maintained the odd spelling “hisingrit”). In this context, he expressed disapproval of von Kobell (1828), who had introduced a new, superfluous name, “thraulit”, for a mineral from Bodenmais, Switzerland, that obviously was hisingerite. The present accepted English name, “hisingerite”, was first seen in print in a publication by Phillips (1823).

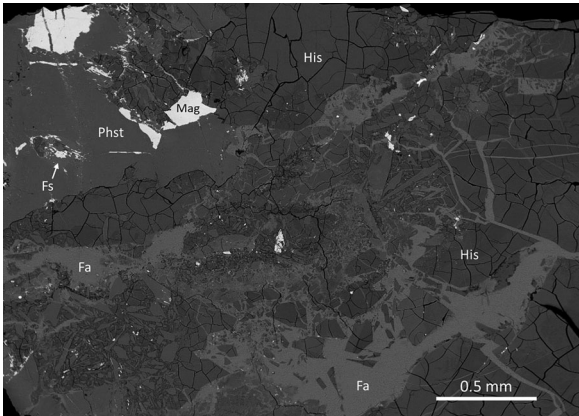
### Type material

Regarding possible candidate samples for type material, Cronstedt’s vast mineral collection was sold to a foreign collector and its current whereabouts are not known (Zenzén 1931). The Hisinger collection is preserved by the Department of Geosciences, Swedish Museum of Natural History (NRM). A specimen, originally labelled “jernoxid-silicat” (iron-oxide silicate) from Gillinge (Fig. 1; GEO-NRM #19205376) and a few specimens (e.g., GEO-NRM #19205366) of “jern-silicat” from Riddarhyttan, are likely the most promising, since they bear Hisinger’s own handwriting. It can, however, not be definitely proved that these were the samples analysed by him, but the specimens can serve as reference material for future investigations, and a neotype could be defined following the appropriate procedures (Dunn & Mandarino 1987).

Interestingly, a preliminary closer examination of the Gillinge sample shows that the material is heterogeneous, with several iron-rich minerals present (Fig. 2). Hisingerite is associated with fayalite, potassic-hastingsite, magnetite and minor ferrosilite. The high Al content (5.5 wt.-%  $\text{Al}_2\text{O}_3$ ) found by Hisinger (1810) is explained by the presence of the amphibole potassic-hastingsite,  $\text{KCa}_2\text{Fe}_5\text{Si}_6\text{Al}_2\text{O}_{22}\text{OH}_2$ . In fact, in his later life, Hisinger (1843) wrote that “gillingit”



**Figure 1.** Colour image of the hisingerite specimen (circa  $4 \times 5 \text{ cm}$ ) from Gillinge, GEO-NRM #19205376.



**Figure 2.** Backscattered-electron SEM image of a polished section of the hisingerite specimen from Gillinge, GEO-NRM #19205376. Mineral symbols: Fa = fayalite, Fs = ferrosilite, His = hisingerite, Mag = magnetite, Phst = potassic-hastingsite.

probably was an impure hisingerite contaminated with “argillaceous earth” (i.e., aluminium oxide). The exceptional value for the density obtained at the time of the original publication was likely an effect of the admixture of the heavier minerals noted.

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No potential conflict of interest was reported by the author(s).

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## References

- Berzelius, J.J., 1814: Försök, att, genom användandet af den electrokemiska teorien och de kemiska proportionerna, grundlägga ett rent vetenskapligt system för mineralogien. A. Gadelius, Stockholm. 103 pp.
- Berzelius, J.J., 1819: *Nouveau Système de Minéralogie*. Mequignon-Marvis, Paris. 315 pp.
- Berzelius, J.J., 1828: *Die Anwendung des Löthrohrs in der Chemie und Mineralogie*. 2nd edition. J.L. Schrag, Nürnberg. 282 pp.
- Berzelius, J.J., 1829: *Årsberättelse om Framstegen i Fysik och Kemi*. Norstedt, Stockholm. 133 pp.
- Brigatti, M.F., Galan, E. & Theng, B.K.G., 2013: Structure and mineralogy of clay minerals. In F. Bergaya & G. Lagaly (eds.): *Developments in Clay Science*, vol. 5, 21–81. Amsterdam: Elsevier.
- Clark, A.M., 1993: *Hey's Mineral Index: Mineral Species, Varieties and Synonyms*. Chapman & Hall, London. 852 pp.
- Cronstedt, A.F., 1751: Rön och försök gjorde med trenne järnmalms arter. *Kongl. Svenska Vetenskaps Academiens Handlingar* 12, 226–232.
- Cronstedt, A.F., 1758: *Försök til Mineralogie, Eller Mineral-Rikets Upställning*. Wildiska Tryckeriet, Stockholm. 251 pp.
- Dunn, P.J. & Mandarino, J.A., 1987: Formal definitions of type mineral specimens. *American Mineralogist* 72, 1269–1270.
- Eggleton, R.A. & Tilley, D.B., 1998: Hisingerite: A ferric kaolin mineral with curved morphology. *Clays and Clay Minerals* 46, 400–413.
- Enghag, P., 2008: *Encyclopedia of the Elements: Technical Data-History-Processing-Applications*. John Wiley & Sons, New York. 1309 pp.
- Hawthorne, F.C., Mills, S.J., Hatert, F. & Rumsey, M.S., 2021: Ontology, archetypes and the definition of ‘mineral species’. *Mineralogical Magazine* 85, 125–131.
- Hisinger, W., 1810: Undersökning af svenska mineralier. VI. Svart stenart från Gillinge jern-grufva i Södermanland. *Afhandlingar i Fysik, Kemi och Mineralogi* 3, 304–306.
- Hisinger, W., 1819: *Versuch Einer Mineralogischen Geographie von Schweden*. 1st edition. Craz & Gerlach, Freiberg. 568 pp.
- Hisinger, W., 1826: *Versuch Einer Mineralogischen Geographie von Schweden*. 2nd edition. J.A. Barth, Leipzig. 250 pp.
- Hisinger, W., 1828: Analyse des mit dem Namen Hisingerit belegten Eisensilicats. *Annalen der Physik und Chemie* 89, 505–508.
- Hisinger, W., 1843: *Handbok för mineraloger under resor i Sverige*. Norstedt & Söner, Stockholm. 188 pp.
- Mustoe, G.E., 1996: Hisingerite—a rare iron mineral from Walker Valley, Skagit County, Washington. *Washington Geology* 24, 14–19.
- Phillips, W., 1823: *An Elementary Introduction to the Knowledge of Mineralogy*. 3rd edition. Philips & Yard, London. 406 pp.
- Treiman, A.H., Bish, D.L., Vaniman, D.T., Chipera, S.J., Blake, D.F., Ming, D.W., Morris, R.V., Bristow, T.F., Morrison, S.M., Baker, M.B., Rampe, E.B., Downs, R.T., Filiberto, J., Glazner, A.F., Gellert, R., Thompson, L.M., Schmidt, M.E., Le Deit, L., Wiens, R.C., McAdam, A.C., Achilles, A.N., Edgett, J.D., Farmer, K.S., Fendrich, K.V., Grotzinger, J.P., Gupta, S., Morookian, J.M., Newcombe, M.E., Rice, M.S., Spray, J.G., Stolper, E.M., Sumner, D.Y., Vasavada, A.R. & Yen, A.S., 2016: Mineralogy, provenance, and diagenesis of a potassic basaltic sandstone on Mars: CheMin X-ray diffraction of the Windjana sample (Kimberley area, Gale Crater). *Journal of Geophysical Research: Planets* 121, 75–106.
- von Kobell, F., 1828: Ueber das Eisensilicat von Bodenmais (Thraulit). *Annalen der Physik und Chemie* 90, 467–469.
- Zenzén, N., 1931: Axel Fredrik Cronstedt – bergmästare, kemist, mineralog. *Svenskt Biografiskt Lexikon* 9, 279–284.