



The bicentenary of Georg Hartung, a German pioneer geologist and explorer

Carlos A. Góis-Marques^{1,2}, Miguel Menezes de Sequeira^{1,4}, José Madeira^{2,3}

5 ¹Madeira Botanical Group (GBM), Faculdade de Ciências da Vida, Universidade da Madeira, Campus da Penteada, 9000-390 Funchal, Portugal

²Instituto Dom Luiz (IDL), Laboratório Associado, Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

³Departamento de Geologia, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

10 ⁴CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, InBIO Laboratório Associado, Pólo dos Açores, 9501-801 Ponta Delgada, Portugal

Correspondence to: Carlos A. Góis-Marques (c.goismarques@gmail.com)

Abstract. We present a tribute to Georg Friedrich Karl Hartung (1821-1891), a less-known non-academic German geologist, on his 200th anniversary. Influenced by eminent 19th century scientific personalities such as Oswald Heer, Charles Lyell, and
15 Alexander von Humboldt, he performed pioneer geological observations and sampling in the Azores, Madeira, and Canaries volcanic archipelagos. Later in his life he travelled to the USA and explored the Scandinavian countries. His scientific endeavours were published in several books and papers, many of them co-authored by academic German geologists and palaeontologists. His works on the macaronesian islands are deemed as classics, many enriched by his own detailed geological illustrations.

20 1 Travels, influences, and published literature

Georg(e) Friedrich Karl Hartung or Georg Hartung, was born on the 13th of July of 1821 in Königsberg (then Prussia, now Kaliningrad, Russia), and perished in Heidelberg (Germany) on the 28th of March 1891 (e.g. Bouheiry, 2015; Lindemann, 1891; Pinto and Bouheiry, 2007). He was born in a well-established and wealthy family, and his father owned a printing and a publishing company, being responsible for the publication of the journal ‘Hartungsche Zeitung’ (Bouheiry, 2015). To date no
25 known portrait is available (Pinto and Bouheiry, 2007; A. Bouheiry, personal communication), although he represents himself in his geological drawings taking notes/sketching (Fig. 1A; 1F) or talking to local people (Fig. 1B).

Most information about Hartung comes from his own work or correspondence (Pinto and Bouheiry, 2007; Bouheiry, 2013, 2015; Sarmiento Pérez, 2004). Hartung received a degree in Agronomy (1841-1843, University of Greifswald) (Bouheiry, 2015). In 1855 he took private geology lessons with Gustav von Leonhard (1816-1878) (e.g. Pinto and Bouheiry,
30 2007) and in 1862, he receives an honorary doctorate from the University of Königsberg, most probably due to his geological

works on the Atlantic islands (Reifs, 1891; Bouheiry, 2015, 2013). Moreover, he was a gifted illustrator considering his geological sketches (Fig. 1C, D, E, F and G).

In the winter of 1850/51, suffering from catarrh, Hartung travelled to Madeira Island (Portugal) to seek a milder climate to ameliorate his poor health condition (Pinto and Bouheiry, 2007). In Funchal, he met the Swiss palaeobotanist Oswald
35 Heer (1809-1883), who travelled to Madeira due similar health reasons (e.g. Schröter and Heer, 1885; Bouheiry, 2013). During this stay, Hartung accompanied Heer fieldwork (Heer, 1857; Schröter and Heer, 1885). Heer influenced him to start studying the geology of Madeira Island (Bouheiry, 2013). Hartung returned to Madeira Island in the following winter (1851/52), also traveling to Porto Santo and Tenerife (Canary Islands, Spain) to make geological observations (Bouheiry, 2013). On his return to Madeira in the winter of 1853/54, he met the English geologist Charles Lyell (1797-1875) that had travelled to Madeira to
40 study the geology of the Atlantic Islands. According to Wilson (2007), Lyell went to Madeira to evaluate the catastrophist theory of ‘craters of elevation’ postulated by Leopold Von Buch (1774 – 1853) (Buch, 1826), against his uniformitarian views (Lyell, 1855). Lyell choose Hartung to accompany him due to his geological curiosity, knowledge of the Portuguese language, and the geography of the island. Both travelled to Madeira and to the Canary Islands (Spain) of Tenerife, La Palma and Gran Canaria (Pinto and Bouheiry, 2007; Wilson, 2007). In the winter of 1854 Hartung proceeded alone to explore the Canary
45 Islands of Lanzarote and Fuerteventura (Bouheiry, 2015). Lacking a formal geological education, in 1855 he took private geology lessons with Gustav von Leonhard (1816-1878) (Bouheiry, 2013).

Hartung planned to publish the geological observations of Madeira and the Canaries archipelagos with Lyell, but due to Lyell’s schedule this never came to fruition (Bouheiry, 2013), although a manuscript draft by Lyell with several sketches and illustrations by Hartung does exist (see Lyell and Hartung, 1856, unpublished manuscript). In 1856, during a meeting
50 with scholars in Berlin including Lyell, Hartung was encouraged by Alexander von Humboldt (1769-1859) to travel and study the geology of the Azores Archipelago (Bouheiry, 2015, 2013) and he, in fact, travelled to the Azores archipelago in 1857. During his stay in Azores, he produced a manuscript (Hartung, 1857a) on the geology of Terceira Island (see Pinto, 2007). Having explored the archipelagos of Madeira, Canary and Azores, he proceeds in 1858 to 1861 to explore the volcanic areas of Germany to compare them with his own observations in the Atlantic islands (Bouheiry, 2015). He started to publish his
55 results on Lanzarote and Fuerteventura (Hartung and Arlett, 1858; Hartung, 1857b), on the Azores (Hartung, 1860a, b) and on the Gran Canaria (Hartung, 1862). Hartung further publishes his observations on Madeira and Porto Santo Islands (Hartung and Mayer, 1864), and is co-author in a book about the geology of Tenerife (Fritsch et al., 1867). Due to his work, he receives in 1862 an honorary doctorate from the University of Konigsberg (Reifs, 1891).

Between 1870-71 period, corresponding to the war between France and Germany, he travelled to the United States
60 of America where he met Louis Agassiz (1807-1873) at Cambridge, Massachusetts (Bouheiry, 2015). Reports of this travel were published in his home journal ‘Hartungsche Zeitung’ (Bouheiry, 2015). In 1873 he changes his research focus, travelling to Sweden, leading him to further explore the Scandinavian countries (Bouheiry, 2013, 2015). The results of these explorations were published in three books (Hartung and Dulk, 1877; Hartung, 1877a, 1882) and on a report on plant fossils (Hartung, 1877b). Last known writings appear mainly in the journal ‘Zeitschrift der Gesellschaft für Erdkunde zu Berlin’ (Hartung,



65 1878a, 1879a, b, 1880a, 1881a, b, 1884, 1885) geological discussions were published in other journals (see Hartung, 1880b, 1878b).

Hartung's own geological observations and certainly the influence of Lyell and Heer ideas, led him to provide detailed field evidence against catastrophic theories, pointing out in favour of the gradual upbuild of the Atlantic islands, the formation of valleys by erosion or the uplift movements (Pinto and Bouheiry, 2007). Furthermore, he was also a pioneer in what concerns
70 to collecting geological and paleontological specimens (but also entomological and botanical specimens; see Bouheiry, 2013, 2015), that were delivered mostly to German and Swiss academics for study and description, which were later published in Hartung's own books or in separate papers (e.g. Heer, 1857; Hartung and Mayer, 1864). This legacy allowed, in recent decades, to localize the fossiliferous outcrops described by Hartung almost 200 years ago and to obtain new and important data on the geology of these sites and to collect new fossil specimens (e.g. Madeira et al., 2007; Góis-Marques et al., 2018; Góis-Marques
75 et al., 2019).

Despite the perseverance to travel in hard conditions and his publication track, Hartung is still a less-known figure in Geology, and further efforts are needed to put together the life of this explorer. Important data and clues to his scientific views and relations to other fellow geologist and other scientists are certainly to be found in his unpublished correspondence, namely to Heer (Bouheiry, 2013) and in his reports to the 'Hartungsche Zeitung'. As pointed out by Pinto and Bouheiry (2007), the
80 achievements of this German geologist should not be forgotten and should be celebrated as classic works on the geology of the Atlantic Islands.

Data availability. No data sets were used in this article.

85 **Author contributions.** All authors contributed equally.

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190 **Figure 1:** Georg Hartung geological illustrations. **A** and **B**, details of two illustrations depicting Georg Hartung performing fieldwork. **A**, G.
Hartung (left figure with a hat) taking notes from his guide in Fuerteventura Island, Canary archipelago (extracted from plate III in Hartung,
1857b); **B**, Same person in São Miguel (Azores archipelago) talking with the locals (extracted from plate VII in Hartung, 1860a). **C**, **D** and
195 **E**, examples of geological sketches and cross-sections of Madeira Island extracted from Hartung and Mayer (1864): **C**, sketch of Boaventura
valley (fig. 1 in plate VIII); **D**, idealized cross section in a volcanic terrain (fig. 2 in plate VIII); **E**, sketch of south coast of Madeira Island
from 'Forte de São Tiago' (Funchal) to Ponta da Oliveira (Caniço) (Fig. 5 in plate III). **F** and **G**, landscape drawings: **F**, view from Las
Canadas into the Teide stratovolcano, in Tenerife Island; **G**, View from the top Penha d'Águia, Porto da Cruz, Madeira Island, extracted
from Ziegler et al. (1856). Notice that the depicted persons are probably Hartung wearing an umbrella while sketching, and his local guide,
waiting for him. All images are public domain courtesy of the ETH-Bibliothek Zürich (<https://www.e-rara.ch>).