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The identification of a potential fossil from the “Geopark Karnische Alpen”

Introduction

The identification of an unknown fossil is an important part of paleontology. Different methods are applied to gather more information about potential fossils. Difficulties can arise from the limited number of methods that can be used, especially since in most cases destructive analyses are not an option. This is especially true for loaned items or items of exceptional rarity. This, however, does not mean that there are no ways to accomplish such a task. It is important to identify potential organisms since they can reveal information about a location's past and past environments. In this article one such potential fossil is discussed. It is a loan from “Geopark Karnische Alpen” that was not yet identified. In this article the potential fossil will often be referred to as unknown structure or simply structure. The preservation and its features leave only a select few specie as possible candidates. These species include Polyplacophora, Multiplacophora, Machaeridia and Serpulidae. The features of the structure are mainly its worm-like shape as well as its segmented appearance. While the discovery and identification of a fossil can be exciting it is importuned consider all options. Another possibility of identification is that it is not a fossil at all but instead a pseudofossil. A geological anomaly that resembles the appearance of an organic organism or tracs of such but instead are formed due to specific geological or hydrogeological conditions. Alongside with literary research and comparison with know species the structure was also analyzed using Raman spectroscopy.

Geological overview

Carnic Alps

The Carnic Alps are part of Austria, Italy and Slovenia and are, to the north, bound by the Gailtal and the Lesachtal. The Carnic Alps are part of the southern alps and are clearly disconnected from the eastern alps by the periadriatic seam. The southern alps developed mainly through fault blocks and in this part of the alps the Permian was mostly of marine nature. The Carnic Alps represent a history from the Ordovician to the Triassic (Fohrer and Samankassou, 2005). At the beginning of the Paleozoic a few terrains split from the northern Gondwana margin and moved north. Part of this group were also the precursors of the Carnic Alps. In the late Ordovician they had a latitude of about 50°S, later in the Silurian they had already drifted to a latitude of 35°S. In the Devonian they reached the tropical belt. All this is evident in the litho- and bio-facies of the Carnic Alps. The carnic alps where to a big part influenced by the Variscan orogeneses, they possess pre-, post- and Variscan sequence. The oldest fossil baring rocks are part of the pre-variscan sequence. They are represented by rocks from a shallow water, medium-high latitude environment. Fossils that can be found in this formation include bryozoans, brachiopods, echinoderms, trilobites and gastropods. The formation that follows, albeit not directly, shows a slightly deeper water environment and is of late Katian age. During the Silurian the depositional environment shifted between shallow water and deep water, there are four lithological facies that can be identified. These lithological facies can be distinguished by their depositional depth and hydrodynamic conditions. The four facies are a proximal, two facies of intermediate depth and one that correlates with a deep-water environment. In the lower Devonian there are several different environments developing. This period is characterized by intertidal lagoonal deposits, reef and fore reef limestone but also deep oceanic offshore shales can be found. The reefs developed at that time reached their maximum during the Givetian and early Frasnian at a latitude of about 30°S. An abundance of fossils can be found in these rocks, manly stromatoporoidea, tabulate and rugose corals, brachiopods, crinoids, gastropods, ostracods, bivalves, cephalopods, trilobites, algae, calcispheres, and foraminifers. Covering the variscan sequence is the permo-carboniferous sequence. Due to a change in sea level caused by the glaciation with the same name, repeating cycles of fluviodeltic and marine sediments can be observed. The base layer of this sequence consists of conglomerates that are overlaid by other sediments. In the upper Permian continental rudistic deposits form primarily Tarvisio Breccia and Sesto Conglomerate. After these deposits marine to terrigenous sediments were formed, followed by evaporitic, lagoonal and shallow marine deposits. The depositional environment consisted of alluvial fans interchanging with alluvial plains that show irregular braided rivers (Corradini et al., 2017).

Gailtal alps

The Gailtal alps are part of the southern side of the eastern alps. Located in Austria the Gailtal Alps are part of the Drau Range (Bemmelen, 1957). The carbonate sediments in the Gailtal Alps began to form in the early to middle Triassic boundary. These rocks show a depositional environment of a restricted and periodically hypersaline shallow marine area. What follows are organic rich and partly hemipelagic, these originate in the upper Anisian to lower Carnian. When the Wetterstein carbonate platform started forming, the area started to disconnect from the open shelf area. This process led to the formation of partially restricted shallow marine sediments, i.e. a restricted lagoonal area (Vozár et al., 2014).

Possible origins of the unidentified Structure

There are a few possibilities that come to mind regarding the identification of the structure or fossil. If it is looked at as a possible fossil the organisms that it bares resemblance to, would be Polyplacophora, Machaeridians or some form of Spirobranchus. If the structure is presumed not to be a fossil, it could potentially be some form of hydrological deposition.

Polyplacophora:

At first glance the structure on the pebble does bare resemblance to the so-called Chiton i.e. Polyplacophora. They share a similar body form as well as potentially their dorsal shell plates. What makes the classification as Polyplacophora unlikely is the fact that Chitons usually only possess eight dorsal shell plates or valves (Irisarri et al., 2020). There is a different group of organisms falling under this category, the Multiplacophora. This group possesses more than eight dorsal shell plates or valves, but in their case the plates are arranged in columns. Included in these 17 plates are only one head and tail plate each but the rest of the plates in between are positioned in three columns and five rows (Vinther et al., 2012). For what is visible in the unidentified structure only one column of plates is visible. This one column, however, is surrounded by potentially a ring of plates or other structures. It cannot be excluded that this structure represents another column of plates or that part of the structure broke off during transportation. But even in that case due to the way the plates in the group of the Multiplacophora are arranged, the 17 plates are not in one row. This would mean that this group also does not possess enough plates for an identification of the structure. Regarding the size of Polyplacophora, they possess a large range of body sizes from 3 mm to up to 43 cm (Salvini-Plawen, 1985). The Multiplacophora are of considerably smaller size ranging from only a few mm to under 3 cm (Vendrasco et al., 2004; Puchalski et al., 2009).

Machaeridia:

The Machaeridian described a group of marine animals, which possess an elongated body which is covered by columns of bilateral symmetric shell plates (British Museum and Withers, 1926). These plates are composed out of calcite and possess two differentiated layers. The inner and outer layer bear distinct growth patterns. For the outer layer there are lamellar fine growth lines and for the inner layer it shows a radial pattern originating from the plate’s umbo, as well as a muscle scar. They were probably a relatively successful group and can be found from the early Ordovician to the Pennsylvanian (Adrain, 1992).

The group can be separated into different families by their number of columns, among other things (Adrain, 1992). Three families are descripted, the Plumulitidae, Turrilepadidae and the Lepidocoleidae (Vinther and Briggs, 2009). The Plumulitidea are covered with several rows of plates, that have a distinct shape that thins out as it goes further back which gives it a triangular or spiny appearance. This is especially true for the outer plates, but the inner plates also present this feature even though to a lesser extent. Similarly, the plates of the Turrilepadidae also appear to be triangular. The Lepidocoleidae on the other hand show a less developed shape. Here the plates appear to be less protruding. These organisms can have many more segments than is the case for Multiplacophora. In case of the Lepidocoleidae they can possess up to 60 segments but also substantially less. The body of the Lepidocoleidae shows a lateral compression and show only two rows of plates (Dzik, 1986; Högström et al., 2009). Both the Turrilepadidae and the Lepidocoleidae are almost completely enclosed by their plates (Vinther and Briggs, 2009). With respect to size the Machaeridian are not known to exide an estimated length of 12 to 25 cm. These uncharacteristically large individuum all belong to the family of the Plumulitidae. The family of the Lepidocoleidae is smaller in size only measuring a few millimeters to a few centimeters. In the case of fossils that show a size of several centimeters they also possess a large number of plate pairs in a short amount of length. For example, an individuum of approximately 28 mm in length already shows between 14 and 15 plate pairs. The width of such a fossil also only measures about 4 mm (Högström et al., 2009).

Serpulidae:

The Serpulidae belong to the class of the Polychaeta and the phylum of the Annelida. They are a group of worms that are characterized by their ability to form calcareous tubs which they attach to surfaces. They are benthic primarily marine animals, which generally do not leave their tubs after constructing them. In most species the tubes show two different layers. Both layers show fine lamination (Hove and Hurk, 1993). It is known that recent species can reach considerable sizes, but a point must be noted that even though their length can be several cm long, the diameter of the tube does not increase that rapidly (Sanfilippo et al., 2017).

Material:

The fossil is adhered to a large pebble about 6 cm in diameter at its longest axis. Both structure and pebble can be seen in figures 1 and 2. The pebble is very well rounded and of oval shape and much lighter in color than the fossil. The color of the pebble is white, gray to yellow. Since the fossil seems to be well preserved and sits on already rounded parts, this would suggest that the fossil had to have formed after the pebble has already been deposited at the location of discovery.

Figure 1: Unidentified structure on pebble, top view.

Figure 2: Unidentified structure on pebble, side view.

The fossil itself has a length of about 4 cm and wraps around the pebble. The surface of the unidentified structure on the quartz pebble is of a rough appearance. The surface consists of different colored aggregates, with different degrees of crystallization. The most dominant phases are a darker, brown to blackish mineral and a lighter reddish-brown phase. The color of the fossil varies from reddish-brown to a light yellow. There seems to be damage to one end of the fossil where part of it has been broken off. Inside the space created by the damage the color differs from the rest of the fossil and is more of a grayish yellow. The potential fossil discussed in this article possesses at least 17 well to semi-well-defined segments, as can be seen in figure 3.

Figure 3: Unidentified structure on pebble, side view, 17 numbered segments visible (Blue).

The location where the potential fossil was discovered is not fully known this is also true for the person who found it and brought it to the “Geopark Karnische Alpen”. The only known information can be found on the opposite side form the fossil. Even though the writing in pencil is difficult to identify it most likely reads “8.5.2001 Zitterbach”, which probably refers to the date and location of the rock’s discovery. The aforementioned “Zitterbach” probably refers to the small stream in Hermagor, Carinthia (AT). Hermagor lies near the border to Italy and in between the northern Carnic Alps and the southern Gailtal alps. The Zitterbach is running roughly from west to east and end up in the Gössering (OpenStreetMap, 2026).

Methodes:

To discover more about the mineralogical composition of the unidentified Fossil, Raman spectroscopy was used. The analysis was done at the Karl Franzens University of Graz, with the Raman micro-spectrometer WiTec Alpha 300. For the analysis the green laser unit was applied with 532 nm and 25 mW.

Results:

With help of the Raman spectroscopy the previous assumption of the host mineral being quartz was confirmed. Due to the in some cases low crystallinity not all aggregates could be identified. The main minerals of the structure consist of Graphite, Goethite and Rutile. The high quality index (HQI) of Graphite as seen in figure 4, is quite low with a value of 15.42. This most likely is due to the very low grade of the graphite. The highest HQI ramen analysis of Goethite shows a value of 37.16 (figure 5). The best result in terms of HQI is visible in figure 6 with Rutile. Rutil has an HQI value of 67.00.

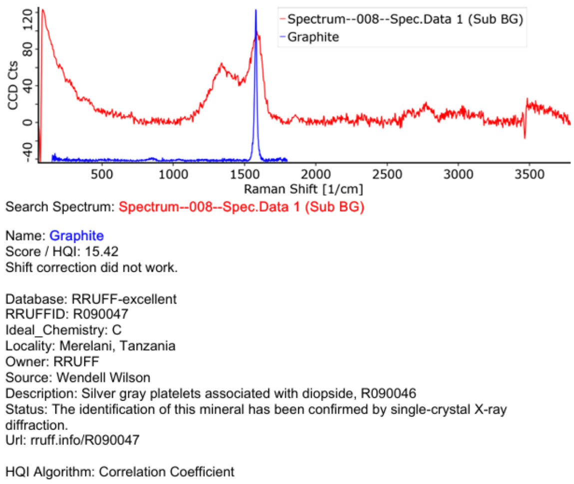

Figure 4: Graphical results from the Raman spectroscopy for Graphite.

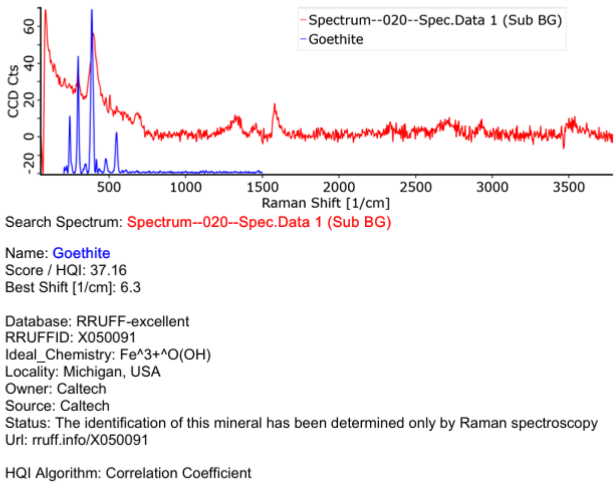

Figure 5: Graphical results from the Raman spectroscopy for Goethite.

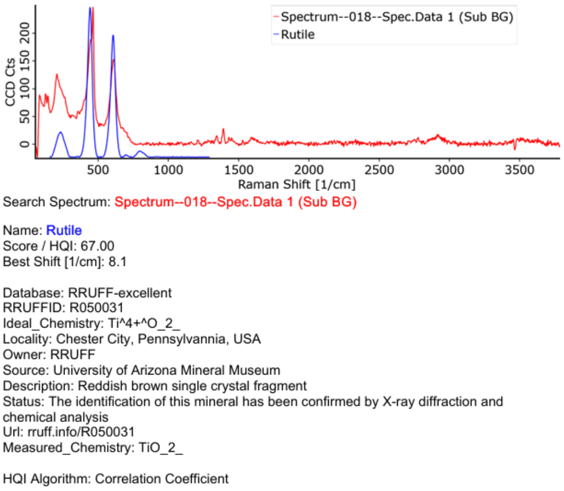

Figure 6: Graphical results from the Raman spectroscopy for Rutile.

Discussion:

The main minerals of the structure consist of Graphite, Goethite and Rutile. Due to this composition and the lack of any other identifiable mineral phases there is a possibility that the actual structure is not visible anymore but that it has eroded. Before the removal took place a hydrogeological deposit potentially filled the structure. If this were the case, that would suggest that not the outer structure of the shell got preserved but the inner one. This composition most likely suggests a hydrological deposition, since heavier minerals like Rutile can be found.

Each possibility of what the structure could be if it is indeed a fossil has its own strengths and drawbacks. At first glance the group of the Polyplacophora has allot in common with the unknown structure. Even though the size would be very fitting, which is rare, the fact that Polyplacophora have a very specific number of plates excludes that possibility. It can be observed that the structure on the pebble possesses more than eight of these plates. The related group of the Multiplacophora carry other issues. For one, although they can possess enough plates to fit with the structure, the issue lies with their arrangement. The structure can be observed to have only one central row of plates, but this is not the case for the Multiplacophora. Another crucial aspect of identification is the size, here it seems that the structure is vastly too big for a Multiplacophora.

Similar problems of size can be observed in the other groups as well. The group of the armored worms, the Machaeridia, are generally of similar appearance. Of the 3 groups the Machaeridia can be split into, the most similar in appearance would be the Lepidocoleidae. This group lacks the very distinct spiny appearance of the other groups. Two problematic aspects of this group would be their size as well as their form. They in general have vertically compressed bodies while the structure seems to be horizontally compressed. This would be the case for the Plumulitidae since they seem to have a flattened body. Their distinct plate shape and the fact that they in most cases bosses 4 rows of plates make the identification with this group unlikely. Similar points can be made regarding the Turrilepadidae. The size of the Machaeridia does not fit the criteria. While they can possess an impressive number of plates, they are much smaller in size and an exemplar of the size of the structure would have to possess significantly more plates than 17 if it were part of the Machaeridia. The structure also lacks any kind of obvious laminar structure which can be found quite consistently within Machaeridia fossils.

When only considering Size the Serpulidae potentially fit the structure, but the trouble here is that the length to width ratio is most commonly vastly different than that of the structure. While some species of Serpulidae can reach considerable length their width only reaches that of the structures if the organism would be much longer. The structure also shows segmentation and while Serpulidae do posses visible growth rings they do not show as strong of a segmentation than the structure. Another aspect is the lack of opening where the worm would come out to feed. The structure does have an opening on the top but considering the rough edges and discoloration it seems to be secondary and not as originally formed. Of course, if only the infill of the original fossil would have remained the opening would not be visible as an opening but there would still potentially be a shape reminiscent of one.

During literary research one noticeable difference between the structure and the compares fossils arose. Whiles it might not be impossible for a fossil to be preserved this way, for the animals it shares commonalities with it seem to be an unlikely way of preservation.

Conclusion:

The Raman spectroscopy results cannot confirm that the structure is a fossil. The mineral phases that were able to be identified all suggest hydrological deposition of heavier minerals. If considered a fossil the most likely scenario would be that the shell of an organism got filled in with this hydrological deposition followed by the erosion of the shell itself. On first glance the structure bares resemblance to a former organism, even though the way of preservation as well as the place of discovery seem unconventional. The origin location and the fact that parts of the structure seem to be damaged do evoke the possibility that more of it is missing or not any more visible due to weathering. Transport for its origin or primary depositional environment could not be too far, since the segmented appearance is still present. It is clear that the pebble experienced substantial fluvial transport before the structure adhered to it. If this structure is indeed a fossil the former organism most likely had to have possessed an exoskeleton or other form of shell, since the most likely scenario of preservation would be an infilling of the structure based on the Raman spectroscopy results. This combined with its worm-like appearance leads to a few candidates. Even though some species could potentially fit the criteria of the structure, all have one or more features that make it highly unlikely as a positive identification. Most commonly the size is an issue as it appears to be somewhat uncommon to encounter a worm-like organism with an exoskeleton of that size. In cases where this was not an issue like the Polyplacophora or the Serpulidae other aspects ruled these identifications out, as there are too many or too little segments visible for a specimen of that size. It cannot be excluded that there is a species that fits all criteria or that the necessary identifiers were lost in the natural transport processes. Instead of a fossil this structure could have possibly been formed by very mineral rich water that left the deposition on the quartz pebble and was undisturbed during that process. As of now, since no suitable species could be found the most likely explanation is that the structure is a pseudofossil. It would be of interest to revisit the proposed candidates and where possible, create models of their inner structures to be able to adequately compare these with the structure.

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