The problem of coin insertion into the joints of the Giant's Causeway: some observations and possible remedial measures

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BRITISH GEOLOGICAL SURVEY

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The problem of coin insertion into the joints of the Giant's Causeway: some observations and possible remedial measures

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Reviewer

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Front cover

Image showing deformed and oxidised coins lodged within the joints of an individual basalt column of the Giant's Causeway.

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1 Introduction

Recent years have seen the emergence of a new ‘ritual’ amongst visitors to the Giant’s Causeway involving the insertion of coins (of any denomination and currency) into the natural joints and fractures that exist within the basalt rock from which the Causeway is formed. This practice is founded on superstition and a belief that good fortune will be bestowed on the donor of a coin(s). The existence of the ‘ritual’ has seemingly become common knowledge and, based on anecdotal evidence, it is actively promoted by external tour party guides. As a result, coins are now present in greater or lesser concentrations across the two most accessible parts of the Causeway.

The proliferation of coins at the Giant’s Causeway has become a source of major concern to both the National Trust (NT) and the Giant’s Causeway & Causeway Coast World Heritage Site Steering Group (GCWHSSG). These concerns centre on the visual impact of the coins and the possibility that their presence is generally detrimental to the rock mass and, ultimately, compromising its structural integrity. A decision was consequently made to approach the British Geological Survey (BGS) and seek some independent advice on the matter and potential approaches to monitoring and/or remediation.

Following discussions between Nikki Maguire (representing the GCWHSSG) and BGS, Drs Stephen Parry and Jeremy Rushton travelled to Northern Ireland in mid-October 2022, visiting the Causeway for around 3 hours on the afternoon of the 17th. During the course of this visit, Drs Parry and Rushton were able to make direct visual observations across the Causeway site and also witness first-hand the process of coin insertion. Drs Parry and Rushton provided a verbal summary of the outcomes of the site visit the following day at the 51st meeting of the GCWHSSG.

This report serves to formalise the content of the verbal presentation given by Drs Parry and Rushton on 18th October 2022.

2 Geological background

The Antrim Lava Group (see Cooper, 2004) is a lithostratigraphic bedrock unit consisting mainly of basaltic rocks that covers much of Co. Antrim and parts of Co. Londonderry and northern Co. Armagh. In detail, the Group is subdivided into the Lower Basalt Formation (oldest), the Interbasaltic Formation and the Upper Basalt Formation (youngest). Around 60 million years ago (Cooper *et al.* 2020), during the period of intense weathering associated with the development of the Interbasaltic Formation, the northern Co. Antrim area witnessed the eruption of a series of basalt (strictly *tholeiite*) lavas. Referred to collectively as the Causeway Tholeiite Member, these lavas infilled a palaeotopography that had developed at the top of the underlying Lower Basalt Formation. Ponding in the palaeovalleys resulted in relatively slow cooling of the lava and the establishment of conditions favourable to the formation of the spectacular columnar jointing for which the Giant’s Causeway is famed. Subsequent denudation of the Antrim Lavas during the later Palaeocene and Eocene, and episodic loading and unloading by glaciers during the Quaternary, promoted the opening of existing joints in the rock mass and the development of others. The current crustal ‘equilibrium’ was likely established in the wake of the last widespread ice advance, some 14 000 years ago (see Bazley, 2004).

The lavas of the Causeway Tholeiite Member show a consistency in their petrographic character, being composed of very fine-grained augite, plagioclase feldspar and opaque minerals, with rare phenocrysts of feldspar and olivine, and patches of glass (quenched lava) (see Cooper, 2004 and references therein). Mineralogically, these constituents belong to the silicate and oxide groups, and are enriched to varying degrees in iron, magnesium, calcium, sodium and titanium.

3 General observations and comments

The key observations made during the site visit can be summarised as follows. Images referred to in the text are contained in Appendix 1.

- Coins of different types have been forced into the columnar joints and other fractures that exist naturally within the basalt rock mass of the Causeway (Image 1). This has been achieved using readily available pieces of rock debris as makeshift hammers.

- The coins that are lodged within the Causeway columns are of different denominations and currencies. Most were found to be of UK or EU origin, but a substantial number of US and 'other European' coins were also observed. See further comments in Appendix 2.

- Coins are particularly abundant in easily accessible locations found close to the bus turning circle, and most notably within the exposures of 5–6 m tall columns that lie immediately east of the bus turning circle.

- Coins are distributed along the length of individual joints and fractures, irrespective of their orientation (Image 2), and repeated insertion at a single point is commonly observed (Image 3).

- Coins are not always found in easily accessible locations, and some visitors clearly put themselves at significant risk of injury in order to insert coins within particular joints/ fractures (Image 4.)

- Damage to the basalt rock neighbouring the joint openings evidently results from the physical insertion ('hammering in') of the coins. (This was actually observed during the course of the site visit.) The visitors responsible clearly believe that the practice in which they are engaging is wholly acceptable and they are unaware of the consequences of their actions.

- Fracturing and disintegration of the basalt rock adjacent to joints and fractures into which coins have been inserted would appear to result from the expansive delamination of the coins (or at least certain types of coin) upon oxidation (see images 2, 5 and 6). The mechanism by which this is occurring is explored further in Appendix 2.

- The oxidation and associated breakdown of iron-bearing coins results in the release of iron oxide and iron oxyhydroxide minerals, which discolour the surrounding rock (see images 1–6). This is unsightly and undesirable, especially given that this is not a phenomenon associated with the natural weathering of the basalt rock of the Causeway. See also Appendix 2.

In summary, there is demonstrable evidence that the practice of inserting coins into the joints and other fractures of the Giant's Causeway is having a detrimental impact on the constituent basalt rock, both physically and aesthetically. The processes associated with the degradation of the coins are seemingly accelerating the break-up of the Causeway rock mass that occurs naturally through physical and chemical weathering.

4 Next steps and possible remedial action

Options in the circumstances range from simply accepting that the practice of coin insertion is now part of the visitor ‘experience’ and allowing it to continue unchecked to banning it outright and removing the many (thousands of) coins that have already been lodged in the joints and other fractures of the Causeway. A form of compromise probably offers the best way forward in the short-term, but we note – based on the observed impact of the coins on the basalt rock mass – that the former is clearly not an option in the longer term.

We briefly suggest some possible courses of remedial action, commenting as appropriate on the strengths and weaknesses of these approaches. It is appreciated that the following list is far from exhaustive, and our aim is simply to stimulate further discussion amongst those responsible for the management and preservation of the Causeway.

High-resolution LiDAR monitoring of (sections of) the Causeway rock mass

Probably best implemented as an academic collaboration, this would provide a wholly non-invasive means of investigating and monitoring movement on individual joints and larger sections of the Causeway rock mass. There are clearly potential health and safety benefits here (in that any structurally weakened parts of the Causeway could be identified in advance of possible collapse), but we note that pure monitoring such as this would not address the problems created by the coins that are already embedded within the Causeway.

Education of the visitor community

We see education of the visitor community as essential and an integral part of any remedial strategy. Awareness of ‘the problem’ unquestionably needs to be raised and visitors to the Causeway must be actively discouraged from engaging in the practice of coin insertion. Science- and mythology-based messaging could be attempted.

Coin removal

There are obvious benefits attached to the removal of the coins already embedded in the Causeway. This could be achieved chemically, but the reagents involved are liable to be harmful to the broader environment and could exacerbate the coin-induced damage to the basalt at the joint margins. Physical/mechanical removal of the coins is the alternative option, and the tools and techniques employed in dentistry could offer possibilities in this respect. It would be highly worthwhile undertaking a series of trials to assess the efficacy of particular approaches and, ultimately, develop a methodology that could be applied to the Causeway as a whole. It should be realised at the outset, however, that any Causeway-wide coin removal project will be both time consuming and financially costly.

Appendix 1 Images referred to in text

Image 1. Image showing coins of different types lodged in a gently undulating, inclined joint within a basalt column forming part of the Giant's Causeway. The pen, for scale, has a diameter of 10 mm at its widest point.

Image 2. Image showing two intersecting joints of different orientation, both of which bear coins along their entire length. Note the deformed and oxidised state of the coins. Note also the relatively un-weathered state of the basalt seen locally towards the RHS of the image (where it appears dark grey), suggesting that expansion-related detachment has occurred recently in this area. Human hand for scale.

Image 3. Image showing a pair of sub-horizontal joints within an individual basalt column of the Giant's Causeway. Both of the joints are laden with coins, which are deformed (due to 'hammering' at the time of insertion) and oxidized. Note the distribution of the coins, in particular the evidence of repeated insertion where the lower joint is at its widest.

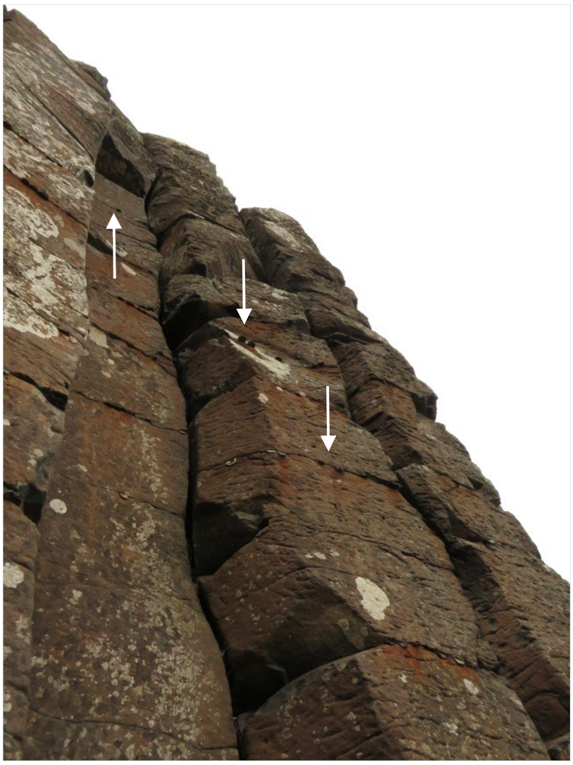


Image 4. Image taken looking obliquely up a series of 5–6 m tall basalt columns. Patches of ochreous discolouration on the rock surface are indicative of the presence of coins within nearby joints (some examples highlighted by arrows). These locations are not readily accessible.

Image 5. Image showing a fragmented joint margin resulting from the expansive delamination of coins inserted into the joint. Note the missing piece of basalt rock above and to the right of the pen tip; residual pieces of two coins can be seen in the joint recess. The pen, for scale, has a diameter of 10 mm at its widest point.

Image 6. Image showing fragmented joint margins resulting from the expansive delamination of coins inserted into the joints. Note the dark, relatively un-weathered appearance of the basalt recently exposed through fragmentation and detachment of the joint margins. The ochreous staining seen in places attests to the presence of oxidised coins within the joints.

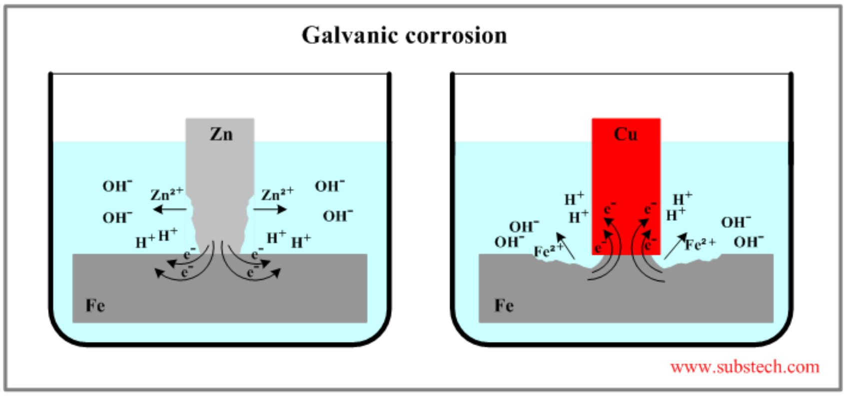
Appendix 2 Further information on the corrosion of the coins in the Causeway environment

Coins exist in a variety of forms, differing in terms of both metals used and structure. Many, for example, are made predominantly of one metal, with a thin coating of another. UK ‘copper’ coins, since 1992, have comprised a steel core with only a thin layer of copper on the outside, while 5, 10 and 20 pence pieces, since 2012, have comprised nickel-plated steel. Other coins employ two metals as part of a ‘two-colour’ design (e.g. UK £1 and £2 coins).

During the site visit, it was noted that the coins found within the joints of the Causeway have a wide range of origins. This equates to a highly varied set of metals, all sitting in direct contact with one another and/or a crystalline rock (basalt) that is rich in iron-, magnesium- and titanium-bearing minerals. Furthermore, in the coastal environment of the Causeway, this metal assemblage is regularly (potentially constantly at particular times of year and under specific weather conditions) exposed to saline seawater spray and aerosols.

Many of the metals and alloys from which the coins are constructed, especially the steel(s), will be prone to corrosion by seawater through exposure to chloride ions. However, with multiple metals being present – sometimes in the same coin, sometimes in adjacent coins – then there is also the potential for accelerated corrosion through *galvanic corrosion*. Also called *bimetallic corrosion*, this is an electrochemical process in which one of two juxtaposed metals corrodes preferentially when they are in electrical contact in the presence of an electrolyte. In the Causeway setting, the seawater is acting as the electrolyte.

Examples of well-known galvanic pairings include zinc-steel and copper-steel. These are illustrated in the diagram below (taken from: http://www.substech.com/dokuwiki/doku.php?id=galvanic_corrosion). In the first example, the electropotentials of the two metals are such that the zinc (Zn) acts as the anode in the resultant electrochemical cell, and it corrodes preferentially or ‘sacrificially’ (this is a typical steel corrosion protection setup). Conversely, in the second example, the steel acts as the anode and corrodes preferentially, preserving the copper (Cu). We note that copper-steel relationships will be common amongst the coins lodged within the joints of the Causeway, and galvanic corrosion cells are likely to have been set up both *within* single coins (the UK ‘copper’ coins for example) and *between* juxtaposed iron- and copper-bearing coins.



It is our belief that the galvanic model of corrosion explains why many of the coins embedded in the Causeway are corroding rapidly and, in so doing, generating ochreous staining – indicative of the presence of ferric oxides and oxyhydroxides – on the exposed rock faces. The increase in volume associated with the formation of the corrosion products is another key consideration here and provides an explanation for the expansive fragmentation of the basalt rock at the joint margins, especially at sites of multiple coin insertion.

References

The British Geological Survey Library holds most of the references listed below and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at https://of-ukrinerc.olib.oclc.org/folio/.

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