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Introduction

In 2007 National Museums Scotland (NMS) purchased a fantastic complete amethyst geode from Rio Grande do Sul, Brazil.

A specialist dealer gave an assurance of authenticity, a choice of several pieces/ dimensions (accompanied by photographs) and prices. The pieces chosen have aesthetically pleasing shapes and the crystals show top quality deep purple colour. Their shapes are significantly different to the normal oval or cathedral arch-like amethyst geodes. This large, stunningly attractive amethyst geode, in two parts (1100 Kg and 1200kg) was purchased to be displayed in one of the new science galleries. Indeed these giant (over 1.88m tall), multiple lobed geodes are unlike anything seen in other UK museums and have an immediate impact on visitors, leaving a lasting memory. The proposed new geology exhibit entitled Restless Earth created the perfect location to display this iconic item.

The gallery portrays our habitable planet as a dynamic system. A large globe displays earth changing events - earthquakes, volcanic eruptions, tsunamis and landslides. An array of rocks, fossils and minerals are also displayed - evidence of the Earth's structure and processes.

The Geology of Geodes

The name geode is derived from the Greek word "Geoides" which means Earth like, referring to the shape of the Earth, since many geodes are spherical. A geode is a hollow cavity lined with crystals that can form in any void within a rock. When a cavity is completely filled (e.g. an agate) it is called a nodule.

The most common method by which geodes are formed is when a bubble is trapped in cooling volcanic lava. This can sometimes merge into single large bubbles or lobed aggregates. Over time permeating mineralised fluids fill the cavities and crystals grow. Each geode has a unique size, shape and crystal formation. Although some may be similar in composition and origin, no two are exactly alike. The rough exterior of the geode gives no indication of the secrets held within. This is only discovered when the geode is cracked open or cut with a rock saw.

For many years geologists have tried to explain how geodes form and several theories have been explored. Both Kantor (2003) and Macpherson (1989) have different explanations as to how crystallisation from mineralised solutions can generally occur within a cavity. Regardless of which theory is correct the outcome is the same: a spherical or distorted gas cavity lined with microcrystalline material and/or crystals.
The mineralised fluids permeating in the Rio Grande do Sul lavas can give rise to a number of precipitates. Most common are varieties of quartz, but calcite, barite, gypsum and goethite amongst others are also found.

The quartz crystals can be of many colours: smoky, brown, grey, violet and colourless. Amethyst is the purple variety of quartz and is often considered the most spectacular. Amethyst crystals get their colour from trace amounts of ferric iron within the crystal lattice and exposure to natural radiation within the rock.

Giant amethyst geodes occur in few places in the world. Those which occur in the Brazilian state of Rio Grande do Sul are abundant and are of the highest quality. A methyst geode 'caves' and 'cathedrals' have been found in this locality. The geodes are found within a huge basalt formation known as the Parana basalts, which formed 130 million years ago.

Most mining is done by driving tunnels (up to 150m) into the richest basalt flows allowing large geodes to be located. A small hole is drilled, and then a light inserted to check the size and quality of the amethysts. Decisions are made on the method of extraction depending on the assessed quality of the geode. If it is identified as being of good quality it will be removed very carefully (although breakages can occur). Those of poorer quality will be broken and sold in small pieces (Balser 2008). Each year two to three thousand tons of agate and amethyst are exported from this region to all parts of the world. (Currier 1997).

Transport and storage

Before packing, vulnerable micro-fractured areas between crystals were consolidated with epoxy resin and the outer surfaces reinforced with toning plaster (Currier 1997).

The supplier then packed each part of the geode into wooden, locally made crates, which had reinforced bases designed to allow vertical storage and transportation. The packing materials comprised plastic film wrap, bubble wrap and lots of sawdust.

When the crates arrived at NMS (Figures 1-2) and were opened in May 2007, the packing material covering the geode's surface was removed (Figures 3-4). After thorough visual inspection, no damage was detected. Some small areas were recorded as vulnerable and images were taken for the record.
The closed crates containing the geodes were stored in a temporary area in a horizontal position for easier handling and to allow access by exhibition designers and planners.

During the next two years the crates were moved on numerous occasions with lifting pallets to allow construction work on the building to be carried out.

Re-crating the geode

By summer 2009 overloading of the crate by storing in a horizontal position had caused structural failure. Both crates were broken (Figure 5). A condition report was commissioned to establish how best to move the crates without causing damage to the geodes. The report concluded that new crates should be constructed with reinforced bases, to allow the geodes to be safely stored horizontally. The geodes were transferred by an external contractor supervised by an NMS conservator.

The external contractors built a metal A-frame (similar to that shown in Figure 2) to support the weight of the geode. This was reinforced with extra padding in vulnerable areas. Lifting slings were inserted under the geode and then attached to metal bars fixed to tensioned cables (Figures 6-8). These cables allowed good control when lifting. The slow motion allowed listening carefully for cracking sounds therefore avoiding damage to the geode. The sawdust packing was re-used in the new crate to support the geode until the crates were transported to the final destination on the floor above.

The geodes were safely stored in the new crates until the permanent display space was completed.

Final Destination

The new challenge at the beginning of July 2011 was to move the geodes to an upper level for display in the Restless Earth Gallery, their final destination. A spider crane (Figure 9) was hired to carry out this complex and specialist job. Because the spider crane required the full floor space, the two parts of the
geode were the first specimens installed in the gallery.

The geodes were unpacked, checked for conservation requirements, and prepared for display. The official date for the NMS opening was 29th July 2011, four years after the geodes arrived.

A metal frame (Figure 10) was constructed to support the geodes which were to be displayed back to back. After an engineer checked that all the metal frame supports were safe, a wooden skirting structure was constructed around both part of the geode. All dust, sawdust packing and building debris around the structure and between crystals were removed with a vacuum cleaner and air dusters before the visible parts of the frame were painted to blend in with the matrix.
Conclusion

This experience has facilitated a better understanding of the importance of “this way up” instructions during transport and storage, especially when dealing with extremely heavy brittle objects. Many of the complexities associated with moving this type of object particularly in small, restricted areas surrounded by glass display cases, have also been learned.

There is a high potential for damage to heavy/vulnerable objects during lifting and it is essential to have even distribution of weight with no pressure on any particular point during handling. When handling objects that have been prepared elsewhere and little information has been provided, it is important to think the worst. The geode may have had areas vulnerable to fracture which were camouflaged by the plaster reinforcement.
Throughout the long journey from Brazil to Edinburgh (10,000 km) and during the many transfers within the Museum, these spectacular geodes were not damaged and so vital conservation work was not required.

This fantastic amethyst geode display now has pride of place in the recently completed Restless Earth Gallery (Figure 11). Since the reopening of NMS in summer 2011, around 3 million people have visited the museum.

References
CURRIER, R. June 1997 (Last Updated: 7th Jun 2013). Everything you always wanted to know, and needed to know about amethyst specimens, but were afraid to ask. www.mindat.org