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"DO-IT-YOURSELF" (DIY) Geointerpretation – Making Geology Simple, Fascinating & Fun

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ABSTRACT

Why does the earth-quake? When does the land-slide? How do rocks bend and break and what makes lava flow and mountains grow? Geointerpretation activities can explain these fascinating and seemingly incomprehensible global phenomena in simple and fun ways to visitors, tourists and the public. According to renowned interpreter Sam Ham (Ham, 1992), this involves "translating complex technical language and concepts into terms and ideas that people can readily understand"; while "doing it in a way that is entertaining and interesting to people". Meanwhile almost 2500 years ago, the Chinese philosopher Confucius elegantly confirmed that "if we hear we forget, if we see we remember but if we do we understand". Geotourism activities within Global Geoparks across the world cater for geotourists who want to know more about how the earth system works, as well as to experience the wonders - (and terrors) - of the natural world. Do-It-Yourself (DIY) geointerpretation activities are simple to design, inexpensive to create and very flexible to deliver to geotourists, anywhere. This hands-on workshop will reveal how geointerpretation is made easy using simple everyday materials. For example, making your own banana benders, broken egg-shell planets and lava sandwiches will demonstrate many geological processes including difficult concepts such as Deep Earth, Deep Impacts and Deep Time. Geointerpretation makes visitor experiences (within Geoparks) more enriching, fulfilling and most importantly fun!.

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1. INTRODUCTION

The complex behavior of geological materials as they are transformed from detrital debris into soft sediments which then become hard and rigid horizontal rock strata; or from these layered piles to emerging mountain chains where the layers are warped and folded or cracked, broken and faulted, are concepts which are difficult to translate (and interpret) into the language that the public can understand.

Trained earth scientists understand and describe such complex features and interactions or processes in terms of engineering and mechanical concepts, including settling of sediments in water columns, compaction and cementation, stress and strain, elasticity and brittle failure, fracture, rheological viscous flow, plasticity, creep and ductility. Important to the understanding of how rock materials behave include topics of the homogeneity, anisotropy and continuity of these materials. During their formation, deformation, and failure rock behavior can, however, be modelled quite simply using everyday materials and objects to bring the reality of geological processes to life.

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These material behavior processes may be analysed quantitatively and mathematically by scientists, but this is of little relevance to the untrained public. However, visitors to geosites or Geoparks are likely to observe the resultant products of these complex processes and may be able to comprehend what rock behavior looks and feels like if it is interpreted sympathetically using materials and processes they are familiar with. The use of a range of model materials and simulations using readily available and cheap household objects (e.g., fruit and vegetables), integrated into hands-on activities can be used via geo-interpretation to widen the interest and understanding of the marvels of geological processes.

Just as complex geological processes and rock behavior might confound tourists and visitors, more intangible geological concepts like the vastness of (Deep) geological time and the earth's (Deep) interior are also likely to be unfathomable and in need of sensitive geo-interpretation.

2. METHODS

The research method used is a qualitative method that consists of observation, documentation, and interviews. According to renowned interpreter Sam Ham (Ham, 1992), this in-volves "translating complex technical language and concepts into terms and ideas that people can readily understand"; while "doing it in a way that is entertaining and interesting to people". Mean-while almost 2500 years ago, the Chinese philosopher Confucius elegantly confirmed that "if we hear we forget, if we see we remem-ber but if we do we understand". Geotourism activities within Glob-al Geoparks across the world cater for geotourists who want to know more about how the earth system works, as well as to experi-ence the wonders - (and terrors) - of the natural world. Do-It-Yourself (DIY) geointerpretation activities are simple to design, in-expensive to create and very flexible to deliver to geotourists, anywhere. This hands-on workshop will reveal how geointerpretation is made easy using simple everyday materials.

3. RESULT AND DISCUSSION

Geointerpretation

Geointerpretation is by necessity very varied. Rather than using the more conventional printed booklets or signs there are examples of more involved interactions or presentations which are currently being used to interpret geological processes to, and with, the public, Cousins (2021) demonstrates the use of visual and physical theatre for popular (geo)science communication (Figure 1) revealing re-enactment of fossilization, planetary accretion and condensation, and climate emergencies through visual simulations to engage and excite his audience.

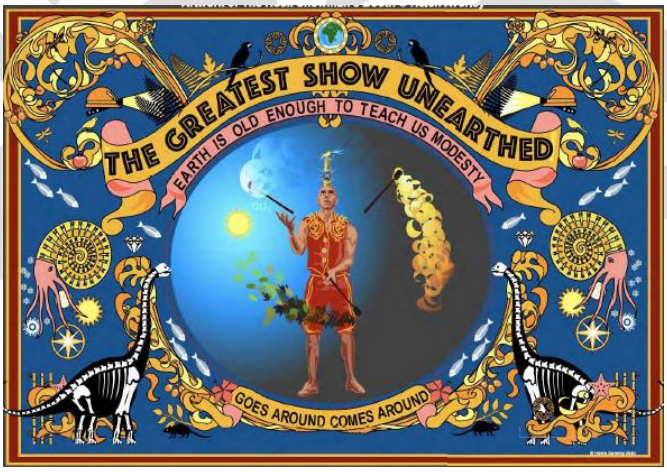


Figure 1. Artwork of the Rock Showman's Booth at Let's Circus and the Rock Showman (Cousins, 2021)

Similarly in South Australia Michael Mills (aka Professor Flint) uses performance, music and theatrics to engage (mostly young) museum and festival attendees to engage and highlight the lives and deaths of the dinosaurs amongst other geological and palaeontological stories (Figure 2). Whilst Dinofest's life-

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size animated models (Figure 3) allow young audiences, where they engage with "real" moving dinosaurs. Whilst a dinosaur trail with a life-size T-Rex, a Dino Dig, arts and craft activities, and “feel a fossil” with real dinosaur bones (https://www.dinofest.com/), engage visitors of all ages.



Figure 2 – Professor Flint performs a geointerpretation show at the Art Gallery of South Australia. (https://www.youtube.com/watch?v=GxAgp66sQj0)



Figure 3 – Dinofest 2023 in the Adelaide Botanic Gardens with “pantomime” Dinosaur where two actors in a single costume cooperate and synchronize their movements and are presented and interpreted by a geotour guide.

These examples of contemporary geointerpretation, follow the teaching of Chinese philosopher Confucius who expressed his belief in the importance of learning from experience when he wrote: "I hear, and I forget. I see and I remember. I do and I understand." This concept was more recently codified for geotourists by Professor Sam Ham (Ham, 1992) following the pioneering work of Tilden, (Tilden, 1957), who described environmental interpretation is ‘an educational activity which aims to reveal meanings and relationships using original objects, by firsthand experience and by illustrative media, rather than simply to communicate information. Ham (2007) expanded this to include the need to translate technical language into terms and ideas that people can readily understand and in a way that is entertaining and interesting to those people, and to make them care.

Dowling (2020) supports these concepts that interpretation should be used to help visitors gain not only a knowledge, but also an affinity for the natural and cultural world and that effective interpretation must use both accurate information as well as a variety of interpretive techniques to help visitors respond to the environment “on both an intellectual and emotional level”. Thus, with geointerpretation, visitors can also benefit from face-to-face tours, plus story-telling and presentations as well as traditional communication media such as publications, brochures and websites (Dowling 2020). Hands on activities enhance and stimulate empathy and understanding of geological phenomena and the processes of their formation and are critical in fulfilling the principles of geointerpretation excellence.

Hands-on geointerpretation activities - background

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The theoretical pedagogic framework for active and experiential geo-interpretation requires involvement of geotourists and geo-guides or presenters in engagement, exploration, explanation, elaboration and evaluation. This workshop involves using a range of analog simulations utilising readily available and cheap household materials, which are integrated into engaging demonstrations and group activities.

Wood, rubber, plastics and celery simulate the elastic bending and mechanical failure of brittle materials, allowing the investigation of flexibility versus stiffness, resilience, and strength of "rigid" materials as first scrutinized by Robert Hooke in the late 17th century.

On the other hand, metals, plasticine, yoghourt and dough range in their anelastic to plastic responses, whilst honey, vegemite, beer and soy sauce clearly delineate various viscous behaviors, also initially investigated in the late 17th century by Isaac Newton. Time dependent creep may even be simulated with particle board or gyprock given sufficient time and enough patience (Figure 4).

Other geointerpretation activities investigate the larger scale (in both time and place) geological processes which can be used to help to set rocks, minerals fossils and landforms in more familiar concepts for otherwise geologically unsophisticated tourists. These include exploration of the internal spheroidal shells of the earth's crust, lithosphere and asthenosphere mantle and the Earth's core, whilst tectonic events such as continental extension, rifting, graben formation, sedimentation, mountain building and volcanism are likewise topics and components readily available and relevant for investigation and interaction (Figure 5).



Figure 4 – an array of simple materials, books and artifacts (plastecine, jelly, cloth, crayons, dinosaur lollies etc.) which can be cheaply and easily gathered for geo-interpretation activities

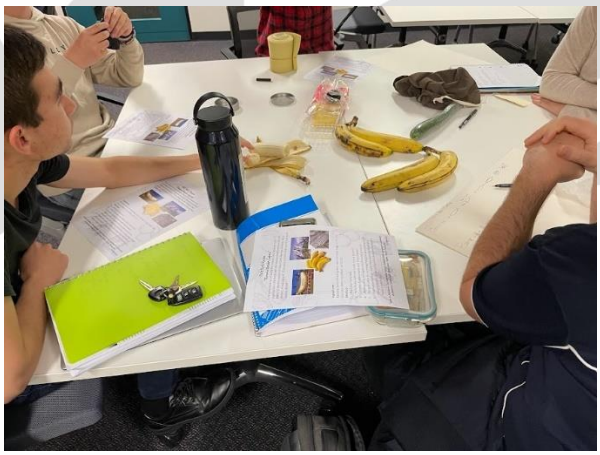


Figure 5. Groups of (5 or 6) volunteer geotourists/geo-interpreters develop an exercise to "make mountains out of bananas".

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Geointerpretation activities examples – method

Some of the following activities described here are designed to engage an audience during simple demonstrations or presentations, while others are more suitable for self-guided group activities which may then be demonstrated to other groups, and can be observed, critiqued and enjoyed by all (Figure 5).

Many of the types of activities presented here have been designed for different audiences. These range from advanced educational experiments and presentations for Tertiary students (James and Clark, 2006) to school age "Earth and Environmental" learning activities for (K-12 students (Van der Flier-Keller, 1998). However, Museums, Earth Science Visitor Centres (e.g. Edinburgh's Dynamic Earth, Adelaide Museum etc.) and many Geopark Visitor Centres provide workshops demonstrations which can make use of geo-interpretation activities similar to those outlined here.

For this workshop, individual hands-on activities are described via a "rock recipe" as in the description of the ingredients needed, preparation and resulting repast. The first three activity recipes were designed for undergraduate learning demonstrations (James and Clark, 2006) but can be easily modified for hands-on activity by geotourists of all ages and backgrounds and can likewise be used as group activities. The subsequent three further activities are examples of a few of the many other (inter)activity simulations which can be undertaken given the time, space, ingredients available.

Banana Bender (Surprise)

The Banana Bender (Surprise) activity uses a banana (or bunch for group study) to simulate the relationship between the application of a compressive force and the resultant deformation which on a global tectonic scale leads to the formation of mountains like the Alps, Himalayas or U.S. Rockies and the smaller scale folds and thrust faults found within them (Figure 6).

Bananas are peeled, squeezed along their length and the resultant squashed banana invariably produces an array of structural features (folds, thrusts, tension gashes etc.) which although unique for each banana are consistent with expectations for compressional forces.



Figure 6 Bananas and zig-zag folds and thrusts on Mt Kidd (US Rockies) modelled by horizontal compression of a peeled banana. Low angle "thrusts" faults and even a subducting wedge occurred during this deformation!

The Ultimate Gummy Sub Sandwich

This activity creates an almost edible sandwich to show the varying runniness of viscous ingredients (aka a tribological investigation), which can simulate how syrupy versus sticky lavas flow from a volcano, or how magma creeps in the mantle, or how landslides might form, or how apparently "solid" rocks can flow given enough time.

Using sliced bread or a sub(way) roll butter or margarine, and a variety of handy spreads such as vegemite (an Australian necessity), honey, peanut butter, tomato and soy sauce, tabasco, mayonnaise and even toothpaste (really?)) plus a knife and lots of paper towel, participants are encouraged firstly to place the ingredients within their jars, tubes or bottles into an order of runniness or stickiness (viscosity). Taking note of the size and shape of the vessels which contain the ingredients and the fact that their shape and nozzles or openings have been designed specifically regarding how viscous the contents are, the sandwich can be constructed (Figure 7), from least to most runny/viscous whilst discussion of how geologic analogs

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(mud, lava or magma etc.) might behave. Persuading the audience to taste the ultimate sandwich is the final task.



Figure 7. The viscous sandwich explores to roll of flow and lubrication (tribology) in the development lavas and landslides.

The Toilet Roll of Time

There are very many explanations, simulations and simplifications used to explore the understanding of deep geological time. Some use digital simulations such as the geological clock animation https://www.edumedia-sciences.com/en/media/910-geological-clock

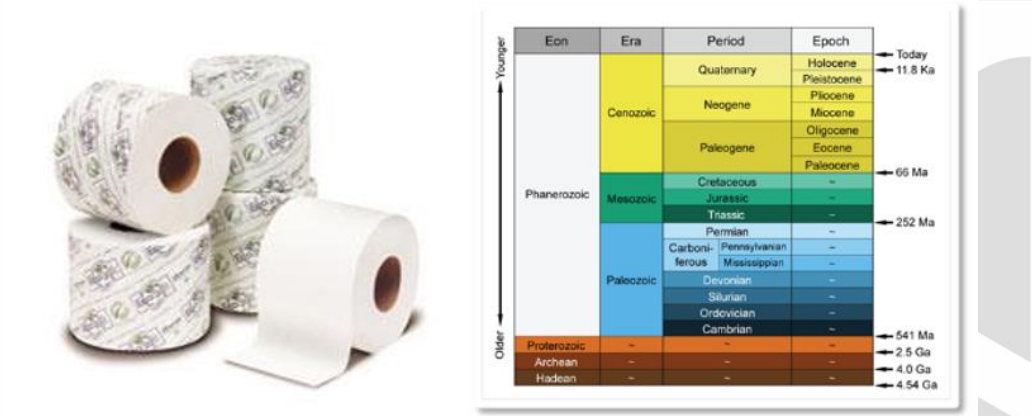


Figure 8 the toilet roll analog for the geological time scale

This uses the “calendar year” metaphor of compressing the 4.6 billion years of Earth's history into a single year.

Other simple methods use linear to represent the age of the earth (e.g., 4.5 paces is about 5 metres). Others use the power of numbers for example forming a queue of people (10 individuals are needed) to represent the 10 numbers making up over 4,500,000,000 years to today.

The activity detailed here however, uses a toilet roll to demonstrate Deep Time and the Earth’s formation (Figure 8). Each sheet of paper on a toilet roll represents about 20 million years and the roll can be unraveled to reveal important local or global geological time Periods or Eras and events such as the demise of the dinosaurs, the Cambrian explosion of life on earth or the snowball earth Cryogenian period.

A Layered Dirt Smoothie

This activity uses a mix of unconsolidated “dirt” to simulate the formation of sedimentary layers and beds; plus, the development of sedimentation features such as “graded way up” structures; stratification following weathering; and the erosion and deposition of sediments in rivers, lakes or oceans.

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Depending on the location where the activity occurs a collection of handy dry unconsolidated matter including pebbles, gravel, grit, sand, dirt, mud, salt, twigs, leaves and the odd snail shell can usually be easily found.



Figure 9 Dry dirt, water and a shake can produce fine sedimentary layering so beautifully preserved in the image on the right from the Flysch Coast shore platforms of the Basques Geoparkea Geopark

The activity is simply carried out by spooning the dirt into a transparent water bottle which is then filled with water and vigorously shaken to imitate a storm, a flood, an earthquake or waves on the beach (Figure 9). The bottle is stood upright and left for an hour or longer if possible, during which time settling and clarifying, distinct sedimentary layers emerge. The finest sediment is at the top and the coarsest at the bottom. Discussions can range from how this helps geologists to recognize the relative age of sedimentary strata to why those strata might be sometimes inverted and to how these fundamental laminations (called bedding) which are seen in most rocks reveal the significant indications of stratigraphic sequences, unconformities, fossil evolution, faulted and folded layers and many others.

Bending and Breaking Bad -

Destructive earthquakes cause enormous and tragic human disasters regularly as well as structural building collapse, and equally devastating landslides and tsunamis Figure 10). However, the earth ruptures which cause the earthquakes are also responsible for the formation of vast mountain chains and the major fractures and thrust faults found within them. This Bending and "Breaking Bad" interpretation activity uses brittle and rigid materials, like wooden or plastic knives and rulers, polystyrene sheets and tiles or celery and cucumber to demonstrate the relationship between bending force and the resultant fracture deformation. This modelling of earthquake fracture shows the relationship between elastic non-permanent and recoverable deformation, whilst emphasizing the properties of all rocks as brittle-elastic materials. Fracturing materials creates not only shock waves and noise but also a permanent crack joint, gash or fault.

Figure 10. Rinjani-Lombok Geopark Visitor Centre destroyed by the 2018 earthquake and the ancient faults exposed in the Canberra Parliament circle underpass, Australia

This activity must be carried out with care and safety in mind. The bar of material (e.g., wood or celery) is held firmly and bent. During this process, releasing the material usually allows it to return to its original shape and the mechanics of Hookean elasticity can be discussed in terms of the similar behaviour of rubber football, golf or tennis balls. Eventually however, when the elastic limit is reached the material breaks, and the resultant fracture, noise, and shock leaves permanently broken fragments emphasizing the irreversibility of this process. Geological analogs such as small joints and veins in hard rock samples make good examples for discussion.

Violent Volcanic Flambe

Many common ingredients can be used to show how and why volcanos spectacularly erupt. Interaction of fizzy drinks, effervescent tablets and whipped cream allow the creation of outpouring and flowing fluids, plumes of billowing cloudy gas. Bread & cakes are used to demonstrate volcanic porphyrys, pumice, breccias, ash and lava (Figure 11).

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Figure 11. Ingredients for simulating volcanic eruptions and a lava lamp to demonstrate plutonic diapirism.

The purpose of this activity is for the participants to design and simulate various types of volcanic eruptions and products. A Gugelhupf or Panettone cake provides the cone shaped model "volcano" and creativity and inspiration encourage the inclusion of foaming whipped cream or warm/runny chocolate to simulate flowing lava. Mentos sweets dropped in (sugar-free!!!) cola bottles "erupt" frothy lavas and shaken and pierced fizzy drink cans can emulate vaporous gas plumes.

4. CONCLUSION

There are many other examples of do-it-yourself activities that can be used to stimulate and engage geopark visitors and other geotourists (see Van der Flier-Keller, 1998). "Smashed Avacados" and "Deep Earth Devilled Eggs" activities explore the internal structure of planet earth, demonstrating in relative terms the 6000km vastness and behavior of its core, mantle and lithosphere. Swiss rolls can be used to demonstrate how different types of folds form within mountain chains whilst, "Liquorice Allsorts" can be used to differentiate fault styles. The possibilities are endless.

Cleaning materials and good humored assistants are an ideal necessity for the aftermath of such group activities, but the sharing of experiences, ideas and knowledge usually brings collegiality and fun to most participants. Just try it!

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