Art-Science connections for the visualisation of minerals: historical precedents for media arts

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Abstract

The Making of Rocks: 'By what furnaces of fire the adamant was melted, and by what wheels of earth-quake it was torn, and by what teeth of glacier and weight of sea-waves it was engraven and finished into its perfect form, we may perhaps hereafter endeavour to conjecture.' [John Ruskin, Modern Painters, vol iv. part v. ch. vii, § 2.]

Visualisation is a complex process for artists and scientists. In both science and art visualisation can refer to objects that have material existence, or the visualisation can be a representation of conceptual or abstract phenomena. One area where there is a rich history of both representation and conceptualisation relevant to a critical understanding of current media arts is in the visualisation of rocks and minerals. This paper will discuss historical examples from the arts and design of the 19th and 20th centuries as the background for considering actual and potential synergies in present day arts-science collaborations that explore visualisation within the earth sciences and specifically mineralogy and crystallography.

This will include reference to current theoretical approaches to visualisation where knowledge building, the expressive potential of visualisation of data, and consideration of visual representations and models as tools and mediators are integral to the complexity of our visual culture.

Keywords

Visualisation, modelling, mineralogy, crystallography, collaboration

Introduction

Scientists, artists, and clerks have been multiplying imageries, intermediaries, mediations, representations while tearing them down and resurrecting them with even more forceful, beautiful, inspired, objective forms (Latour and Weibel 2005, 26).

This paper considers the historical context of the communication of mining cultural heritage and its relationship to new media art, specifically work that builds on arts-science relationships. Mining is a truly global phenomena underpinning industrial development and includes both simple and sophisticated technologies, and pure and applied research. Mining has a rich heritage of knowledge, skills and cultural association – scientific, technological and creative. It also has a cultural heritage that can be transient and disappear almost without trace; or mining activities can leave scars of desolation and pollution within communities and landscapes once corporations have exhausted the resources found in those locations

I will first consider contributions to the visualisation of rocks and minerals from the late 18th century to the 20th century, to contextualise specific relationships between science and art. I will then discuss recent works by artists whose practice provides an understanding and appreciation of certain aspects of minerals and mining; either as an exploited resource, as in the case of works linked to mining heritage, or by those who have explored aspects of minerals such as elements, chemical composition, structure or related geological processes of rock formation.

This is a rich area for exploration literally in terms of its potential for considering the scale of things. It is possible to link minerals to rock formations and geological processes over vast tracts of time. Conversely, it is possible to move from minerals and crystalline structures to the nano-scale.

This overview will show specific synergies and connections between the sciences and the arts, where there is a transition across 'disciplines' as they are developed to provide knowledge and understanding of the Earth. Some of these are smooth transitions and translations, based on similar aims and objectives, or dependent on the use of the same tools and techniques; others are intellectually charged experiments to cross, what at the time, were conceived of as separate 'cultures'.

Visualisation
In existing accounts of visualisation more broadly, Martin Kemp has described a broad sweep across 'structural intuitions', with artists (old master, modern and present) moving from a consideration of analytical description, to abstraction and then to process (Kemp 1998, 875). This means a change from creating a visualisation from an exterior viewpoint to interpreting, constructing and codifying data beyond the reach of bodily senses.

There are specific technologies that have enabled this to happen. Not only have images become more dominant for communication during 20th and 21st centuries (Stafford) but digital forms of visualisation have also become increasingly complex with the development of visual analytics. This discipline is concerned with sensemaking and reasoning (NVAC™ 2004) and is facilitated by interactive visual interfaces. It is a means of synthesising from large datasets, often with conflicting and ambiguous data.

Current developments in visualisation are places in two broad categories - scientific visualisation and information visualisation (Charters 2008). Scientific visualisation is concerned with the conversion of numeric data usually from scientific experiments and simulations, to a graphical representation and mostly deals with data that has a natural geometric structure (e.g., MRI data, wind flows). Information visualisation is a conversion of other forms of data, such as structured and unstructured text, images and video to an appropriate graphic representation. The term 'information visualisation' was coined by Stuart K. Card, Jock D. Mackinlay and George G. Robertson in 1989 (Card et al 1998, 8). Media artists have made use of the software and architectures and associated technologies for works that can be networked, have novel interfaces and can be immersive, interactive, and simulations.

Visualisation of minerals and rocks – art science relationships
I will now consider contributions to the visualisation of rocks and minerals from the late 18th century to the 20th century, to contextualise specific relationships between science and art and the associated access and development of tools and technologies for visualisation.

In 'Art History as the History of Crystallography' James Elkins has raised questions about the expressive meaning of art where images convey 'personal, political, social, psychological, gendered, or other kinds of meaning that artists can more or less freely incorporate into their works' (Elkins 1999, 13). He uses art history's interpretive protocols to provide a visual analysis of crystallography drawing techniques to argue that one of the main movements in crystallography is from 'haphazard naturalism towards geometric abstraction' thus giving an account of a change around 1800 similar to Kemp's category of abstraction. This move to abstraction is further evident in the adoption of clinographic projection, which was universally accepted by the 1880s, or in gnomonic or stereographic projection; the skills for reading these projections are not 'natural' and have to be learnt (Elkins 1999, 20). Interestingly, Elkins raises various historiographical issues; one being that of appropriate explanation, referring to how much specific technical information is relevant for explaining scientific images (Elkins 1999, 14). If discussing pictorial analysis this is an important issue, but as well as linking to the technical, artistic links to mineralogy also lead to cultural meaning, as shown in the following examples which are concerned with the social circulation of images.

My specific historical examples are:
The collection of the late 18th century mineralogist Philip Rashleigh, where illustration was used to communicate and circulate a concern of science.
The critical writing of the 19th century art critic and geologist, John Ruskin, where scientific knowledge was integral to the appreciation of art and the study of mineralogy and geology was used for ethical instruction.
The display of the periodic table at the Festival of Britain of 1951, where science was de-mystified for democratically educational purposes.

Philip Rashleigh
Philip Rashleigh (1729-1811) was a Cornish antiquarian and mineralogist who obtained mineral specimens from the local miners and built up a collection of Cornish minerals that was widely consulted by visitors

during his lifetime. Similar to other collectors at the time, he also built up his own system of classification. The collection passed to a nephew until it became part of the collection in the Royal Cornwall Museum in Truro in 1902. Besides building the collection, Rashleigh put great effort into producing two books of accurate illustrations of the chosen specimens, especially their natural colour. His contribution to mineralogy therefore shows a concern for communication science and making the information visible for circulation and appreciation. (It is still possible to compare actual specimens with the illustrations in the museum display.) He meticulously catalogued his collection, with attention to locality information, which shows the strength of links to the mining industry in Cornwall as did his attempt to collect every variety of tin from Cornwall and elsewhere. Rashleigh did not become proficient in chemical analysis as practiced by some of his contemporaries. He wrote in 1804 'all my knowledge of Chemestry [sic] is so antiquated' (Cleevely 2000, 94).

His contemporaries like the Swedish mineralogist, Axel Fredrik Cronstedt (1722 -1765), developed the use of a blowpipe for analysing the composition and chemistry of minerals. This technique was combined with the work of René Haüy in 1801 to show that crystals cleaved along specific faces, fixed by underlying crystal symmetries. Haüy is considered to be the principle founder of crystallography (Greenberg 2003, 136). Then the combination of chemical and physical analyses culminated in American mineralogist, James Dwight Dana proposing a chemical classification in 1837 that remained functional until scientific advances showed that materials could no longer be compartmentalised according their origin on Earth, other planets, the product of human manufacture or as organic-inorganic (Hemley 1999, 1026).

John Ruskin

Ruskin (1819-1900) was a pupil of Rev. William Buckland (1784–1856) at Oxford. Buckland's theories kept geology in tune with Biblical accounts of creation and were an influence on the young Ruskin, who became a Fellow of the Geological Society of London in 1840. Ruskin's love of geology and in particular the formation and decay of mountains was an important part of his discussion of art in *Modern Painters*. The five volumes, written between 1843 and 1860, showed his appreciation of Turner textually woven with his love of landscape and mountains. Although Ruskin suggested that a geologist could look at a Turner painting and see enough detail to give a lecture on the rock types and formations he also considered that Turner's power was in his ability to create 'not so much the image of the place itself, as the spirit of the place' (Grieve 1996, 230).

Ruskin also considered exaggeration to be necessary for depicting what was important but subtle in nature (Grieve 1996, 232). For Ruskin 'good art rarely imitates' it usually only describes or explains and consisted of 'First, the observation of fact; secondly, the manifesting of human design and authority in the way that fact is told. Great and good art must unite the two; it cannot exist for a moment but in their unity' (Clark 1967, 150). Through his writing, Ruskin was capable of a 'level of close tactile analysis and intense politico-social engagement, sustained by an incomparable verbal re-evocation of artistic experience – ekphrasis' (Kite 2007, 180). Ruskin's achievement was to make the reader feel like a participant in the visual experience he was describing.

In *The Ethics of the Dust*, published in 1866, Ruskin demonstrated that the study of crystallography might teach social reform, political economy, and virtue as well as science. In answer to a question posed in one of the book's lectures: 'Then we may really believe that the mountains are living?' The lecturer replied: You may at least earnestly believe, that the presence of the spirit which culminates in your own life, shows itself in dawning, wherever the dust of the earth begins to assume any orderly and lovely state.' (Ruskin 1877, 211). Ruskin was able to use mineralogy to make connections between the physical world and morality.

Festival of Britain, 1951

The periodic table of the chemical elements is a tabular form of displaying the chemical elements. It is a useful framework for classifying, systematising and comparing different forms of chemical behaviour but has also become a visual metaphor and also serves as a metaphor for the presentation of knowledge in various domains (Lengler and Eppler 2007). It has become a subject of information visualisation in its own right, with variations suggested, including an eight-period table by Charles Janet in 1928 where he combined the periodic table with Niels Bohr's system of electronic configuration (Katz 2001, 327). Mark R. Leach has comprehensively compiled a 'zoo of periodic tables' many of which are metaphorical as well as functional (Leach 2009).

The periodic table was included as an exhibition at the 1951 Festival of Britain display in the Exhibition of Science, held at South Kensington. Ronald Dickens designed a display consisting of a spiral version of the table, and displays that included additional models of atoms. Crystal patterns were also the subject of design experiments through the work of the Festival Pattern group who based their designs on the work of Dr Helen Megaw. The exhibition was didactic but it also aimed to make science feel friendly (Moffat 2000, 103). Science was portrayed as 'natural.' As Isabelle Moffat has suggested, this naturalness of scientific knowledge 'symbolised by the atom, the crystal, or chemical element…sought to foster a visceral familiarity…by immersing the spectator in the concretized shapes of these elements' (Moffat 2000, 105). This foreshadows the immersive and experiential nature of recent digital arts.

Current media arts practice

Within current art practice, there are new media artists who engage with the earth sciences as a source of inspiration, knowledge and data about the physical environment. Going beyond 'illustration', they also engage in a critical discourse about the outcomes of those scientific practices. Similarly those who engage instrumentally with the processes of visualisation, implicit in the production of scientific knowledge in the earth sciences, go beyond replication of process to create a genuine blurring of the boundaries between art and science. As noted by Barbara Maria Stafford this could mean 'imaging may even begin to formulate its own questions and confidently say something about its own ends' (Stafford 1996, 10). Material images can become central to an argument or ideological position.

Gyr and Koumoutsakos have written 'Art is used as a means to illustrate science, on the one hand, and science serves as an instrumentality in creating art, on the other.'(Gyr, Koumoutsakos, and Burr 2000, 65) A common approach in new media arts is to build on and from laboratory experimentation, using scientific visualisation and tools as the generator of ideas, or even using those tools to produce the artwork itself. Scientific visualisation is then conceptualised as an art form. This shift was integral to the project 'Geo/centr/e/i/city-The Earth as Center.' After visiting the Phivolcs' Geology and Geophysics Research Division, the curator of the project, Fatima Lasay noted:

Such laboratory experimentation allowing the visualisation and prediction of natural phenomena also serves to aid discovery and creativity, as well as the synthesis, representation and apprehension of invisible or inaccessible phenomena (Familara et al. 2002, 233).

Cultural sensibilities were also brought to this project in the form of metaphors and myths about earthquakes and volcanoes from the Philippine Islands. Lasay also explained that there could also be a shift when using digital technologies and the computer from technology-focused utility to cultural mediator. The scientific visualisation technologies were a catalyst but not the full story. Distributed technologies provided related opportunities for communication and display.

Embodiment and experience

One common theme is how we, as individuals or cultural groups, are placed within the scale of things. Art installations such as 'Place-Ruhr' in Dortmund Germany (2000) by Jeffrey Shaw (Shaw 2000), 'A Body of Water' (1999) by Paul Sermon and Andrea Zapp (Fuchs 1999), and 'Datamining Bodies in Ruhr' (2000-2001) by Victoria Vesna (Vesna 2000) have shown a range of interventions that extend our appreciation through the use of the cinematic, telepresence and interactivity in different ways. These works also draw from and contribute to a specific cultural context and place and are, in different ways, celebrations and critique of a mining past that is location specific; in this case the coal mining history of the Ruhr region in Germany. Although usually praised and used as examples of exemplar works for their attention to embodiment, these works provide a strong sense of attention to a sense of place and celebration of industrial heritage.

Victoria Vesna has also explored nanotechnology and the relationship of crystals to the molecular, with Jim Gimzewski in through 'ZERO@WAVEWFUNCTION: nano dreams and nightmares'. This digital projection installation used sound, sensors and architecture to give an interactive experience where there was the illusion of manipulation, by visitors' shadows, of C60 molecules. This was first shown at BEAP 2002 and has had subsequent iterations in different venues, alongside the development of the Nanomandala exhibit (Vesna and Gimzewski 2005).

Conclusion

Social and mediated communication

This paper has aimed to show specific synergies and connections between the sciences and the arts. For example, where there was a transition across 'disciplines' as the disciplines were developed to provide knowledge and understanding of the Earth. Some of these were smooth transitions and translations, based on similar aims and objectives, or dependent on the use of the same tools and techniques; others were intellectually charged experiments to cross, what at the time, were conceived of as separate 'cultures'.

Philip Rashleigh was working at a transition point between the visualisation of rocks based on direct observation or through chemical analysis. He was also considering the communication of the information on minerals through commissioning of illustrations for accurate illustration in his books. My next two historical examples, the critical writings of John Ruskin and the display of the periodic table at the Festival of Britain of 1951 were didactic as well as communicative. The more recent examples of art-science explorations by digital artists move more clearly into an investigation of process, both the process of visualisation and the processes of audiences engaging in the work itself. In some of these cases, as with the Ruhr examples mentioned above, there was a mixing of the exploration of digital technologies for creating environments with a critical reflection of mining heritage. These might be termed 'art-technology' explorations rather than 'art-science' investigations. There is additional expressive value within the work, where the work is reinforcing sense of place and location. Knowledge is being created through interpretation; the work is not just 'illustrating' data. Social context is all important.

Visualisation therefore needs to be understood as more about process and its place within the social realm. This highlights the complexity of the visual. Elizabeth Edwards and Kaushik Bhaumik suggest that there is no 'pure visual object as such but only uses of embodied and sensorially engaged sight' (Edwards and Bhaumik 2008, 11). Their description of the 'book' is relevant for other forms of mediated communication. They state:

The visual is used explicitly when one reads a novel, but also implicitly as the reader simultaneously feels his way through the world made up of entanglements – material, emotional, conceptual or sensual – described in the novel (Edwards and Bhaumik 2008, 11).

Besides a reading by the viewer of social context, the response of the viewer and audiences is also integral to visualisation. As the examples of art-science connections show there may be strong didactic intentions; but these were not just about 'objectivity' but were also about a sense of wonder and beauty about the Earth.

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