# Prologue

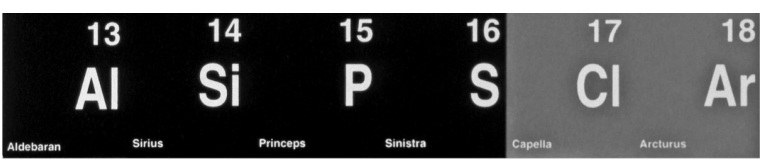
Like the alphabet or the zodiac, the periodic table of the elements is one of those graphic images that seem to root themselves for ever in our memories. The one I remember is from school, hung on the wall behind the teacher's desk like an altar screen, its glossy yellowing paper testament to years of chemical attack. It's an image I haven't been able to shake off, despite scarcely venturing into a laboratory for years. Now I have it on my own wall.

Or at least a version of it. The familiar stepped skyline is there, and the neatly stacked boxes, one for each element. Each box contains the symbol and atomic number appropriate to the element in that position. However, all is not quite as it should be in this table. For where the name of each element should appear, there is another name entirely, one that is nothing to do with the world of science. The symbol O represents not the element oxygen but the god Orpheus; Br is not bromine but the artist Bronzino. Many of the other spaces are taken, for some reason, by figures from 1950s cinema.

This periodic table is a lithograph by the British artist Simon Patterson. Patterson is fascinated by the diagrams that are the means by which we organize our world. His way of working is to recognize the importance of the thing as an emblem of order but then to play havoc with its contents. His best-known work is a London Underground map with the stations along each line renamed after saints and explorers and football players. Strange things happen at the intersections.

It is no surprise that he should wish to play the same game

with the periodic table. He has grim memories of how it was taught by rote at his school. 'It was convenient to teach it that way, but I could never remember it,' Simon tells me. Yet he remembered the *idea* of it. Ten years after leaving school, he produced a series of variations on the table in which the symbol for each element kicks off a false association. Cr is not chromium but Julie Christie, Cu not copper but Tony Curtis; and then even this cryptic system is sabotaged: Ag, the symbol for silver, is not Jenny Agutter, say, or Agatha Christie, but of course Phil Silvers. There are teasing moments of apparent logic in this new tabulation: the sequential elements beryllium and boron (symbols Be and B) are the Bergmans, Ingrid and Ingmar respectively. The acting brothers Rex and Rhodes Reason appear adjacent to one another, co-opting the symbols for rhenium (Re) and osmium (Os). Kim Novak (Na; sodium) and Grace Kelly (K; potassium) share the same column in the table – both were Hitchcock leading ladies. But in general there is no system, only the connections you make for yourself: I was tickled to see, for example, that Po, the symbol for polonium, the radioactive element discovered by Marie Curie and named by her for her native Poland, denotes instead the Polish director Roman Polanski.




I now love the ludic irreverence of this work, but my school-age self would have been quite scornful of such nonsense. While Simon was dreaming up wild new connections, I was merely absorbing the information I was meant to absorb. The elements, I understood, were the universal and fundamental ingredients

of all matter. There was nothing that was not made out of elements. But the table into which the Russian chemist Dmitrii Mendeleev had sorted them was even more than the sum of these remarkable parts. It made sense of the riotous *variety* of the elements, placing them sequentially in rows by atomic number (that is to say, the number of protons in the nuclei of their atoms) in such a way that their chemical relatedness suddenly leapt out (this relatedness is *periodic*, as revealed in the alignment of the columns). Mendeleev's table seemed to have a life of its own. For me, it stood as one of the great and unquestionable systems of the world. It explained so much, it seemed so natural, that it must always have been there; it couldn't possibly be the recent invention of modern science (although it was less than a century old when I first saw it). I acknowledged its power as an icon, yet I too began to wonder in my own tentative way what it really meant. The table seemed in some funny way to belittle its own contents. With its relentless logic of sequence and similarity, it made the elements themselves, in their messy materiality, almost superfluous.

Indeed, my classroom periodic table provided no picture of what each element looked like. The realization that these ciphers had real substance struck me only at the vast illuminated table of the chemical elements they used to keep at the Science Museum in London. This table had actual specimens. In each rectangle of the already familiar grid squatted a little glass bubble beneath which a sample of the relevant element glimmered or brooded. There was no knowing whether they were all the real thing, but I noted that the curators had omitted to include many of the rare and radioactive elements, so it seemed safe to assume that the rest were authentic. Here it was vividly clear what we had been told at school: that the gaseous elements were mostly to be found in the top rows of the table; that the metals occupied the centre and left, with the heavier ones in the lower rows – they

were mostly grey, although one column, containing copper, silver and gold, provided a streak of colour; that the non-metals, more variegated in colour and texture, lay over in the top right corner.

With that, I had to start my own collection. It would not be easy. Few of the elements are found in their pure state in nature. Usually, they are chemically locked up in minerals and ores. So instead, I began to cast about the house, taking advantage of the centuries during which man has extracted them from these ores and pressed them into service. I broke open dead light bulbs and surgically snipped free the tungsten filaments, placing the wriggling wires into a little glass vial. Aluminium came from the kitchen in the form of foil, copper from the garage as electrical wire. A foreign coin that I'd heard was made of nickel – though not an American nickel, which I knew was mostly copper – I cut up into coarse chunks. It was worth more to me like this. It made it more, well, elemental. I discovered that my father had some gold leaf kept from his youth, when he used it for decorative lettering. I removed some of it from the drawer where it had lain in darkness for thirty years and allowed it to shine once more.

This was a definite improvement on the Science Museum. I could not only see my specimens close up, but feel whether they were warm or cold to the touch and heft them in my hand – a bright little ingot of tin, which I had cast in a small ceramic bath from a melted roll of solder, was astonishingly heavy. I could make them ring or rattle against the glass and appreciate their characteristic timbres. Sulphur had a primrose colour with a slight sparkle, and could be poured and spooned like caster sugar. For me, its beauty was in no way tainted by its slightly pungent odour. I have reminded myself of this smell just now, with a tin of sulphur bought from a garden shop, where it is sold to fumigate greenhouses. The dry, woody

aroma is on my fingers as I type, to me not hellish as the Bible teaches, but evocative simply of childhood experimental enquiry.

Other elements needed more work. Zinc and carbon came from batteries – zinc from the casing, which serves as one electrode, and carbon from the rod of graphite inside it that provides the other. So did mercury. More expensive, mercury batteries were used to run various electronic gadgets. By the time they had run down, the mercuric oxide that powered them had been reduced to metallic mercury. I chopped off the ends of the batteries with a hacksaw and scooped out the sludge into a flask. By heating the flask, I was able to distil off the metal, watching as tiny glistening droplets condensed from the thick toxic fumes and then merged into a single hyperactive silvery bead. (The experiment would be banned now for health reasons, as are these batteries.)

A few of the elements you could still buy, in those innocent days, at a dispensing chemist's. I got my iodine in this way. Others came from a small chemicals supplier in Tottenham long since driven out of business by restrictions on the sale of what were of course the raw materials for bombs and poisons – as well as everything else. Although my parents were happy enough to indulge my obsession by driving me there, these trips along the farther reaches of the Seven Sisters Road to the shabby counter beneath the thundering railway arches, with its aromas as promising as any spice market, always had a clandestine feel about them.

I made good progress with my table. I had drawn the grid out on a backboard of plywood and hung it on the bedroom wall. As I got it, I dropped each new sample into a uniform vial and clipped it into position on the grid. The pure elements themselves were often chemically rather useless. I saw that. The useful chemicals – the ones that reacted or exploded or made

beautiful colours – were mostly the chemical combinations of elements known as compounds, and these I kept in a cupboard in the bathroom where I did my experiments. The elements were a collector's obsession. They had a beginning and a compelling sequence. They seemed also to have an end. (Little did I know then of the ferocious cold war between American and Soviet scientists, who were striving to add to the 103 I had fixed in my head by synthesizing new ones.) As a collector, my aim, however unattainable it was destined to be, was of course to complete the set. But it was far more than collecting for collecting's sake. Here I was assembling the very building blocks of the world, of the universe. My collection had none of the artifice of stamps or football cards, where the rules of the game are set arbitrarily by other collectors or, worse still, by the companies producing the items in the first place. This was fundamental. The elements were for ever. They had come into being soon after the Big Bang, and would be here long after humankind has perished, after all life on earth, even after the planet itself has been consumed by its own ballooning red sun.

This was the system of the world that I chose – a system as complete as any other on offer. History, geography, the laws of physics, literature: each was all-embracing according to its lights. Everything that happens happens in history, has its place in geography, is reducible solely to the interaction of energy and matter. But it is also materially constituted of the elements, no more and no less: the Great Rift Valley, the Field of the Cloth of Gold, Newton's prism, the *Mona Lisa*; all impossible without the elements.

At school around this time, we were reading *The Merchant of Venice*. I was Bassanio for one forty-minute session – not a bad role, though I loathed reading out loud. We came at length to the scene when it is Bassanio's turn to select the one of three

caskets that contains Portia's likeness in order that he might win her hand in marriage. The unlucky boy who was Portia prattled on while I waited in dread for my entrance. 'Let me choose / For as I am, I live upon the rack,' I intoned with no feeling whatever. Then I was having to choose between the imaginary caskets. I am sure nobody could have gleaned anything of my character's reasoning from my featureless voice as I rejected first the 'gaudy gold' and then the silver, 'thou pale and common drudge / 'Tween man and man', before plumping for 'meagre lead'. But somewhere inside my head something clicked. Three of the elements! Was Shakespeare a chemist? (Later, I found that T. S. Eliot was a chemist too, a spectroscopist in fact: in *The Waste Land*, he presents a vivid image as a nail-studded ship's timber 'fed with copper / Burned green and orange' – green from the copper, orange from the sodium in the sea salt.)

Dimly, I began to perceive that the elements told cultural stories. Gold *meant* something. Silver meant something else, lead something else again. Moreover, these meanings arose essentially from chemistry. Gold is precious because it's rare, but it's also considered gaudy because it is one of the few elements that naturally occurs in its elemental state, uncombined with others, glittering boldly rather than disguised as an ore. Was there, I wondered, such a mythology for all the elements?

Their very names often spoke of history. Elements discovered during the Enlightenment had names based on Classical mythology – titanium, niobium, palladium, uranium, and so on. Those found during the nineteenth century, on the other hand, tended to reflect the fact that they – or their discoverers – were sons and daughters of some particular soil. The German chemist Clemens Winkler isolated germanium. The Swede Lars Nilson named his discovery scandium. Marie and Pierre Curie found polonium and named it – not without encountering some resistance – after Marie's fondly remembered homeland. A little

later, the scientific spirit grew more communitarian. Europium was named in 1901 – and towards the end of that new century some humorous bureaucrat in one of Europe's banks would decree that compounds of this element should be used for the luminescent dyes that are incorporated into euro bank notes for the easier detection of counterfeits. Who would have thought it? Even obscure europium has its cultural day.

So the elements inhabit our culture. We should not really be surprised at this: they are the ingredients of every thing, after all. But we should be surprised at how seldom we notice this fact. This missed connection is partly the chemists' fault for presuming to study and teach their subject in lofty isolation from the world. But the humanities are also to blame: I was astonished to find, for instance, that a biographer of Matisse could complete her work without saying what pigments the artist used. Perhaps this makes me unusual, but then again I'm sure Matisse cannot have been indifferent to the matter.

The elements do not simply occupy fixed spaces in our culture as they do in the periodic table. They rise and fall on the tide of cultural whim. John Masefield's famous poem 'Cargoes' lists eighteen commodities in its three short verses portraying three eras of global trade and plunder, eleven of them either elements in their pure state or materials which derive their value from the particular nature of one element ingredient, from the quinquereme of Nineveh with its calcareous white ivory to the dirty British coaster with its load of 'Tyne coal, / Road-rails, pig-lead, / Firewood, iron-ware, and cheap tin trays'.

From the moment of its discovery, each element embarks upon a journey into our culture. It may eventually come to be visible everywhere, like iron or the carbon in coal. It may loom large economically or politically while remaining largely unseen, like silicon or plutonium. Or it may, like europium, provide a grace note only appreciated by those in the know.

When I wrote my school essays ('Why does Bassanio choose the lead casket?') it was with an Osmiroid pen, a brand name inspired by the osmium and iridium that its manufacturer used to harden the nibs.

During its gradual assimilation, we come to understand the element better. The experience of those who mine it, smelt it, shape it and trade it gives it meaning. It is through these muscular processes that an element's weight is felt and its resistance is gauged, so that Shakespeare can then refer to gold and silver and lead in the ways that he does knowing that his audience will understand him.

It is not only the ancient elements that are culturally involved. Contemporary artists and writers have used relatively newfound elements such as chromium and neon to send particular signals just as Shakespeare used the elements known in his day. These elements, which fifty years ago signified the innocent glamour of the consumer society, now seem to us tawdry and full of empty promise. The place once occupied by 'chrome' is now perhaps taken by a newer element, 'titanium', which brands fashionable clothing and computer equipment. In such cases, the element's meaning detaches itself almost completely from the element itself: how many more platinum blondes and platinum credit cards (neither incorporating any platinum) there must be than platinum rings. Even some highly recherché elements undergo this shift. 'Radium' was once popular, sometimes in substance, sometimes in name alone, for all manner of health remedies. There are no longer Osmiroid pens, but there is an Iridium telephone company.

If I were to reassemble my periodic table now, I would still want to include a specimen of each element, but I would also want to trace its cultural journey. I feel that the elements leave great streaks of colour across the canvas of our civilization. The black

of charcoal and coal, the white of calcium in chalk and marble and pearl, the intense blue of cobalt in glass and china slash boldly through place and time, geography and history. *Periodic Tales* is the start of that collection.

It is therefore a book of stories: stories of discovery and of discoverers; stories of rituals and values; stories of exploitation and celebration; stories of superstition as well as science. It is not a chemistry book – it contains as much history, biography and mythology as chemistry, and generous helpings of economics, geography, geology, astronomy and religion besides. I have purposely avoided discussing the elements in their periodic table sequence or giving a systematic description of their properties and uses. Other books do this well. I believe that the periodic table has become an icon too powerful for its own good. The ordered grid of squares with its raggedy edges, the strange names and cryptic symbols, the way the elements follow a sequence as fixed yet as apparently arbitrarily as the letters of the alphabet: all these things are strangely compelling. They provide limitless raw material for television quizzes: what element lies directly south-east of zinc?* Who cares? Even chemists do not use the table in this way.

The elements provide the real interest. The periodic table that I once thought of as unquestionable I know now does not really *exist*. A few chemists might deny it, but it *is* only a construct, a mnemonic that arrays the elements in a particularly clever way so as to reveal certain commonalities among them. Yet there's no actual law against arranging the elements by different rules. In his famous song 'The Elements', the American satirist Tom Lehrer reordered them purely for the sake of rhyme and scansion, to fit the tune of Arthur Sullivan's patter song, 'I am the very model of a modern major-general', from *The Pirates of Penzance*.

I wish to discover the *cultural* themes that group the elements

* The answer is indium.

anew, to draw up the periodic table as if sorted by an anthropologist. To this end, I have chosen five major headings: power, fire, craft, beauty and earth.

As Masefield's poem shows, imperial might has always depended on possession of the elements. The Roman Empire was built on bronze, the Spanish on gold, the British on iron and coal. The balance of the twentieth-century superpowers was maintained by a nuclear arsenal based on uranium and the plutonium made from it. In 'Power', I consider some of these elements that have been amassed as riches and, ultimately, used as a means of exerting control.

In 'Fire', I discuss those elements whose burning light or corrosive action are the key to our understanding of them. We may remember from school that sodium, for example, is an element that entertainingly explodes on contact with water, but we *know* it above all as the ubiquitous mango-yellow colour of our street lamps – a very particular light that many writers have seized upon as the index of a general urban malaise.

In the end, any cultural meaning that an element acquires derives from its fundamental properties. This is seen most clearly in the case of those elements that craftspeople have chosen as their raw material. It is the centuries or millennia of hammering and drawing, casting and polishing that have given many of the metallic elements their meaning. 'Craft' explains why we regard lead as grave, tin as cheap and silver as radiant with virginal innocence.

Humankind has manipulated the elements not only for their utility, but also for the sheer joy of the look of them. 'Beauty' shows how the compounds of many of the elements, and the light of others, colour our world. Finally, in 'Earth', I travel to Sweden to discover how particular places have marked many of the elements, and how those places are marked in turn by the fluke of finding an element there.

My own journey has led me to mines and artists' studios, to factories and cathedrals, into the woods and down to the sea. I have recreated early experiments in order to make a few of the elements for myself. I have been pleased to find the elements in abundance in fiction, too, where Jean-Paul Sartre sees fit to remark upon the constancy of the melting point of lead (335 degrees centigrade, he says) and Vladimir Nabokov finds mandalic significance in the carbon atom 'with its four valences'. Wandering through Shoreditch in London on my way to see Cornelia Parker, an artist who has made it her business to remind us of the cultural significance of many of the elements, I was captivated by a sculpture in a shop window by some other artists of a nuclear power station wittily cast like lime jelly in glowing uranium glass. It was clear. The elements do not belong in a laboratory; they are the property of us all. *Periodic Tales* is a record of the journey with the elements that I was never encouraged to take when I was a chemist. Come along: there will be fireworks.