

In their element

At first it was just an unusual, geeky hobby. But by combining their twin passions of chemistry and history, Jim and Jenny Marshall are now running an acclaimed project in science education. **Alexandra Witze** reports.



Not every honeymoon turns into a scholarly project. But that's what happened when Jenny Marshall told her husband, chemist Jim Marshall, that she'd like to spend the summer after their wedding visiting European sites of chemical history.

Six years later, that unusual honeymoon trip has spawned an unparalleled historical investigation. From their home in Texas, the Marshalls travel across Europe every summer to the places where various chemical elements were discovered. They have amassed hundreds of photographs, original documents and many colourful anecdotes — from boating along the coast of Norway in search of thorium, to navigating a muddy Transylvanian track to reach the original tellurium mine.

Few, if any, have stood in quite so many spots where one of the elements was first discovered. "It makes the hairs rise on the back of your neck as you realize this is where history was made,"

says Jim. And as public interest in chemistry flags, the Marshalls see their work as a way to stimulate excitement about a field so rich in history. "Chemical education can be too junior-high-schoolish, with lots of loud bangs and prettily coloured gases," says Jim, "and history can be awfully stuffy and plain and boring."

The human factor

The Marshalls' project is anything but, experts agree. "It gives this wonderful human reality to how chemistry became what it is today," says Alan Rocke, a historian of science at Case Western Reserve University in Cleveland, Ohio. "Scientists are sometimes too ready to ignore their history and the wider culture of their field, and I think that's a loss." Jim Marshall is determined to bridge that culture gap, lecturing regularly on the American Chemical Society's speaker circuit. His web page has become a staple resource for students working on projects about a particular element. And with his wife,

he is compiling a DVD called *Rediscovery of the Elements*, with photos and narratives about their quest, scheduled for release in 2007.

Neither of the Marshalls is a professional historian. Jim teaches chemistry at the University of North Texas in Denton; Jenny is retired from teaching computer technology in local middle schools. Jim's research focus is on organic chemistry and materials science. During the 1980s he worked in industry, including a stint at Motorola that proved key to his leisure-time interests.

At Motorola, Jim began collecting samples of as many elements as he could find. His industry contacts brought him some hard-to-find materials, including promethium from a nuclear reactor at the Oak Ridge National Laboratory in Tennessee. Marshall eventually gathered examples of every element from hydrogen to uranium — the latter represented by armour-penetrating depleted uranium from the tip of a missile stockpiled for the first Gulf War.



Metal mix-up: the Marshalls have shown how a chemist's carelessness meant vanadium was discovered twice

The collection fills a wall of bookcases in the living room of the Marshalls' small town-house. Glass bubbles filled with gas share the shelves with combustible phosphorus, submerged in oil. "I'm afraid to dust because I don't know what will blow up," jokes Jenny.

Historic honeymoon

Given Jim's collection of elements, it seemed natural for Jenny to suggest visiting the sites at which some of them were discovered when the Marshalls made plans for their 1999 honeymoon. That first trip set the pattern: at each site, the Marshalls go forth with historical maps to find the place of interest, cameras to shoot it, and Global Positioning System receivers to fix the location. They then try to secure a new sample, often in the form of a mineral containing the element in question. These 'rediscovery' samples now enrich the original collection.

In many cases, the rediscovery work brought to light stories that were known locally but not widely among historians of science. In Norway, the Marshalls visited mineralogist Alf Olav Larsen for a boat tour along the Langesund Fjord, south of Oslo. They motored along the craggy shoreline, just as Hans Esmark, a local pastor, had done in 1829 while hunting ducks. And they visited a rock outcrop from which Esmark may have chipped a shiny black mineral for the first time. The Swedish chemist Jöns Jakob Berzelius later named that mineral thorite after the Norse god of thunder, and isolated the element thorium from it.

In Romania, the Marshalls travelled to the remote Fata Baii mine in search of tellurium. Franz-Joseph Müller von Reichenstein had identified the element in 1783, after puzzling over what he called a "*metallum problematum*" for several years. Working from descriptions written in the early nineteenth century by a British mineralogist, the Marshalls identified the original mine from which Müller von Reichenstein had obtained his materials. Local

guides led them up a steep, muddy road into the Transylvanian forests, where they finally came across the entrance to the ancient mine, framed by rotting timbers.

Not all the journeys were so arduous. For gallium, the Marshalls tracked down the former home of Paul-Émile Lecoq de Boisbaudran, whose family owned a wine business in the Cognac region of southwestern France. In a well equipped home laboratory, Boisbaudran used spectroscopy to identify an unknown element in an ore mined from the Pyrenees. It melted in his hand — a discovery that delighted Russian chemist Dmitri Mendeleev, who had predicted its properties with his recently developed periodic table of the elements.

In some places, the Marshalls had to dig strenuously to hit pay dirt. In Germany, they eventually found that the laboratory where indium was first isolated is now a bathroom at the Freiberg Academy of Mining and Technology. In Paris, the mining school where chromium and beryllium were discovered had become a children's clothing shop. But even in such places, says Jim Marshall, "you can just smell the history".

In other areas, the Marshalls ran into long-standing disputes over who should be properly credited with an element's discovery. Does the person who first isolated it deserve recognition? Or the one who realized its importance? Thallium, for instance, was first seen in spectroscopic experiments by William Crookes in London. But French physicist Claude-August Lamy cast an ingot of it the next year, grabbing public acclaim for the discovery until Crookes protested loudly and won joint credit.

"Scientists are sometimes too ready to ignore their history and wider culture, and that's a loss." — Alan Rocke

The Marshalls have uncovered new details of a similar misunderstanding over the discovery of vanadium. Historians of science know the tale of Andrés Manuel del Río, a mineralogist in Mexico City who isolated vanadium from Mexican ore. He gave some samples of the new element to explorer Alexander von Humboldt, who took it to Europe and passed it to a French chemist for analysis. Upon testing, he became convinced that the Mexican element was chromium, which like the unknown ore also produced a range of brilliantly coloured salts. And on hearing the findings, del Río retracted his claim to have discovered a new element.

Jim Marshall recreated the French tests in his kitchen sink and found that the chemist had ignored an obvious inconsistency in the colours of certain precipitates. Had he paid closer attention to the colours, Marshall argues, he would have realized that del Río's substance was in fact an unknown element. Instead, it took another three decades before vanadium was 'discovered' by a Swedish chemist. Fortunately, however, del Río did eventually get retrospective credit for his find.

In another case, evidence amassed by the Marshalls may mean history needs rewriting. The discovery of radon is typically attributed to Friedrich Dorn, who in 1900 studied a gas built up inside capsules containing compounds of radium. But the original paper had been incorrectly cited for decades, and its contents drifted into obscurity. So the Marshalls went to Halle, Germany, to find the journal article.

Radon rewritten

Working from the original paper, they decided that Dorn hadn't correctly understood the "emanation" that built up. In the previous year, New Zealander Ernest Rutherford had made similar observations of a different isotope of radon emitted by a sample of thorium, and later to be dubbed thoron. Because he characterized the emanation fully, and placed it correctly in the periodic table, "Rutherford should be given credit for the discovery of radon", the Marshalls wrote in a 2003 paper (J. L. Marshall and V. R. Marshall *Bull. Hist. Chem.* **28**, 76–83; 2003). "Personally, I think they've made an absolutely convincing argument," says Rocke. But he warns that it may take some time for the textbook version of events to incorporate the lessons of the Marshalls' research.

The Marshalls are pleased to have made an original contribution to the history of chemistry, but say that their favourite element remains one whose story is well known: radium, painstakingly isolated by Pierre and Marie Curie from 10 tonnes of uranium ore. Jenny speaks in hushed tones about the time she visited their laboratory, and was allowed to try on one of Marie's smocks. "The story's just so romantic," she says. There speaks a woman whose idea of a dream honeymoon is a voyage of chemical rediscovery. ■

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