signal to background

SLAC's rise from an ancient ocean floor; TV goes underground at Fermilab; a shirt as old as St. Francis; path-breaking bicycle; Czechs tackle Japanese opera; mysterious wine sign; engineering with toys.

Photo: Lizzie Buchen

SLAC's rocky past

Forty members of the Society for Sedimentary Geology drove down Loop Road, passed through the Sector 30 gate, and arrived on the north side of the klystron gallery. Stretching before them, the earthen walls of the accelerator trench cut an enticing swath through the foothills, holding the secrets to a story that began more than 55 million years ago.

Led by geologists Susan Witebsky of the Stanford Linear Accelerator Center and Ken Ehman of Chevron, the group of students, academic researchers, and professional geologists explored the highlights of the lab's tectonically turbulent past.

SLAC's campus rests on a two-mile-thick bed of marine sedimentary rock, a rigid reminder of the waters that covered the land until just recently. The tectonic plate that bears SLAC was once the deep ocean floor, which gradually rose until it broke through the water's surface a mere one million to two million years ago. Each period of this dynamic history left its mark in the earth, depositing minerals and fossilized creatures.

At the start of its October tour, the group heard the tale of *Paleoparadoxia*, a hippo-like beast whose fossils were discovered, excavated, and reconstructed by Adele Panofsky, the diligent and passionate wife of SLAC's founder. At the west end of the two-mile-long linear accelerator, they examined a large mass of land which had, some millions of years ago, been drastically inverted through faulting and folding. A few hundred meters to the south, they studied 165-million-year-old rocks encrusted with fossilized algae barely 40 million years of age. This finding revealed a tremendous deformation of the Earth's surface, which saw rocks 15 kilometers below ground abruptly thrust to the shallow ocean floor.

Certain curiosities, however, remain open questions, such as a glaring 20-million-year gap in deposits, and maverick blocks of sandstone in the otherwise-uniform mudstone matrix at Sector 11.

Although Witebsky has been at SLAC for more than 10 years, the rocks continue to excite and intrigue her. "Our primary job is environmental restoration and evaluating the ground water quality," she says of the SLAC resident geologists. "But every time there's an excavation, like for the Linac Coherent Light Source, we get to come along and see what's revealed. That's the real treat."

Lizzie Buchen

Notes from the underworld

They had braved Parisian catacombs, gloomy dungeons, and shipwrecks. Yet as the elevator dropped 360 feet into a cavernous hall at Fermi National Accelerator Laboratory, uncertainty flickered across the faces of the globe-trotting television crew.

Cities of the Underworld host Don Wildman and his crew had come with the intention of peeling back the layers of the lab as if peeling an onion. Beginning hundreds of feet below ground and working their way to the top of Wilson Hall, the group documented the Tevatron collider, the deep tunnels of the NuMI and MINOS neutrino experiments, and the science that goes on there. The September 2007 filming took two days.

"It turned out great," says Chris Bray, a producer for Authentic Entertainment. "We were worried about the explanation of such abstract and complicated science, but when we showed people an early version, we found that they loved neutrinos." Although the Fermilab segment is brief, he adds, "This really is the star of the Chicago show."

Each episode of the hit History Channel series focuses on the tunnels, tombs, and subterranean hideouts beneath the foundations of today's modern cities. The show has explored the dungeons of Scottish castles, the underground infrastructure of Rome, and the caves beneath Budapest.

While most episodes give viewers glimpses of past achievements, Fermilab's tunnels offered a look at science working to shape the future.

"It appeals to a wide audience. People are fascinated by looking at all different aspects of what goes on in the world," says Mike Andrews, safety coordinator for NuMI/MINOS.

The initial airing of the episode was scheduled for mid-March; see the series' Web page for listings.

Rhianna Wisniewski

Tunic from Cortona

Tunic from Florence

Dating a saint

Two towns in Italy lay claim to relics from St. Francis of Assisi—pieces of clothing and an embroidered cushion from his deathbed.

But one of those relics cannot be authentic because it was manufactured decades after the saint's death in 1226, according to physicists who tested them in May.

Contrary to popular fiction, particle accelerators can't take people back in time. But they can provide time stamps for clothing, books, and other ancient items that contain carbon.

Scientists at Italy's Laboratory of Nuclear Techniques for Cultural Heritage in Florence examined three relics tied to St. Francis, an aristocrat who took a vow of poverty, founded the Franciscan Order, and became the Roman Catholic patron saint of animals.

Examinations conducted at the lab found that a tunic and embroidered cushion housed in the Church of St. Francis in Cortona dated from the time when the saint was alive. However, another tunic from the Basilica of Santa Croce in Florence was made decades later.

The method the researchers used, known as accelerator mass spectrometry, requires much smaller samples than other forms of radiocarbon dating. This allowed the scientists to take five to seven samples of woolen fabric from the tunics, each smaller than one square centimeter; the more samples tested, the more accurate the results would be.

The swatches were treated to extract small pellets of graphite, a form of carbon. These pellets were exposed to cesium ions in an accelerator, releasing carbon isotopes that are counted by a detector. By measuring the ratio of carbon 14 to carbon 12—a delicate undertaking, since there is only one carbon 14 for roughly a trillion carbon 12s—the researchers determined the age of the fabric and discounted Florence's claim to holding this particular piece of history.

Tona Kunz

Photo: Reidar Hahn, Fermilab

Biking the snow away

After seeing a documentary on Ernest Shackleton's 1914 Antarctic expedition, in which men ate shoe leather to survive in bone-chilling temperatures, David Peterson felt kind of silly about letting snow stop his bicycle ride to work.

"There was no excuse," he says. "I've never had to eat my bicycle."

So he built a bicycle snow plow.

On the snowiest days, a half-dozen bicycle commuters form a line behind Peterson and his plow as he clears a path to Fermi National Accelerator Laboratory in Illinois, where he works as an engineer in the antiproton source department.

"They all ride behind me shouting words of encouragement," he says. "Sometimes they take turns on the plow if it's really deep or if I look particularly sad, pedaling."

After experimenting with several different styles of blades and attachments, Peterson settled on two basic methods. For snow more than seven inches deep, he designed a "drift cutter" that can be pushed while walking. In shallower snow he pulls a 70-degree angled wedge plow behind his bicycle; it clears a swath about 18 inches wide. When not in use, the plow pivots on a hitch and hangs over the back tire, inches above the ground.

Peterson gets thank-you e-mails, and occasionally requests for new routes, from walkers, runners, and other bicyclists. In the five years since he started plowing, he says, others have started to pitch in with shovels, snow blowers, and plows hooked up to all-terrain vehicles, although he knows of only one other bike plow like his. "It's like some kind of underground insurgency of snow clearing," he says happily.

Asked if he would ever patent his bike plow, Peterson says no: "I look at it in the same vein as open access publishing. I benefit from things other people put up on the Web, so why should I charge them to look at my plow?"

See symmetrymag.org/plow/ for more details.

Tona Kunz

Czech kimono challenge

Tokio Ohska had an opera to direct.

As always, there were lighting, scenery, and music issues to contend with. But finding costumes to fit a cast of Europeans? That was a new challenge.

Ohska is a physicist. As the head of research services at KEK, the Japanese particle physics lab in Tsukuba, he tends to the needs of foreign scientists and has a knack for making cultures click. But he's also a former professional singer with a background in Japanese opera.

So when a Czech theater company needed a stage director for the first Japanese opera to be sung in Japanese by a European cast, Ohska seemed a natural choice.

Jan Snitil, conductor of the Silesian Theater in Opava, had decided to celebrate the theater's 200th anniversary with a performance from his wife's home country.

"The problem was that the body sizes of Czech singers are much larger than those of the Japanese," Ohska said.

He enlisted a friend to help scour Japanese antique stores for the largest kimonos they could find to match the 200-year-old setting of *Yuzuru*, roughly translated as "the crane at dusk."

"Fortunately, the singers and the conductor are extremely talented, nice people," Ohska says. "They worked with me with a lot of patience and gave me helpful suggestions."

On opening night in October 2007, Ohska sat in the front row, almost holding his breath. As the performance ended he made his way to the stage, expecting polite applause. "But every time I would go to walk off, the curtain would rise again," he says, for a total of 10 thundering ovations: "I was so relieved."

The opera sparked an encore in the form of an ongoing cultural exchange. Opava has since hosted a Japanese culture week; and in 2009, the Czech opera *Dalibor* is scheduled for its first performance in Japan.

Tona Kunz

Photo courtesy of Tokio Ohska

Chateau Neuf du PEP

No one is able to claim credit for the ancient wooden sign that hangs on the porch of the old Positron Electron Project buildings at the Stanford Linear Accelerator Center.

The sign, proclaiming the area "Chateau Neuf du PEP," is a play on the wine they used to drink there. Châteauneuf du Pape is a wine appellation in southern France, named for Pope John XXII's 14th century summer "new home."

"Those were quite different days," says Perry Wilson, a senior scientist on PEP at the time. During the '70s, when the sign went up, PEP collaborators would gather every Friday for refreshments, music, and dancing. Wilson played the gutbucket, a homemade bass. Châteauneuf du Pape, a thick, powerful red wine, was a favorite libation.

Perhaps all that wine addled their memories. Regarding the sign, Wilson points a finger at Francophile John Rees. But Rees, who was director of PEP, denies responsibility. Phil Morton, who was part of PEP's design team, said, "It sounds like something I might have done. I'd like to take credit for it but, I just don't know."

The wine no longer flows, but the well-weathered sign remains, an anonymous monument to the tastes and humor of the old PEP gang.

Amber Dance

Caterpillar crawls to a high-energy rescue

Ryan Schultz and Kris Anderson had a problem: how to inspect a window in a pipe that carries a powerful particle beam, 40 feet below ground and 100 feet down a narrow tunnel.

Their solution: a 15-foot-long contraption that combines a digital camera, a toy Caterpillar excavator, and a scaled-up version of the periscope children use to peer over the backs of sofas. It cost just $200, not bad for a tool that is key to the well-being of a multi-million-dollar experiment at Fermi National Accelerator Laboratory in Illinois.

Directed via a 100-foot remote control cord, the bright yellow excavator rolled into the tunnel, bathed the window in LED light and trained a spotting telescope on it. Watching through a periscope inserted into an access shaft, inspectors on the surface snapped pictures.

The photos came out perfect, and a video of the inspection kept Schultz's 5-year-old son entertained for days.

"He wanted RIC to go with his other toy cars," Schultz says. As for RIC, or Remote Illumination Caterpillar, "he's like a person," Schultz says. "He had his own identity. There's nothing complicated about him. He just does his job."

The window is in a decay pipe linking Fermilab's Main Injector with NuMI, an experiment that shoots a beam of neutrinos through the ground to a detector in Minnesota. It must be periodically inspected for corrosion and other wear and tear.

But since the pipe is encased in concrete, wireless devices won't work, and the low level of radiation in the tunnel fogs photos taken down there.

So Schultz and his supervisor, engineer Kris Anderson, drew on a deep well of experience: hours spent driving remote-controlled cars with their kids.

Meanwhile, senior technician Keith Anderson knew from his days working on US Army tanks that he could devise a periscope to look into the tunnel. "It is mostly modeled after the children's milk-bottle periscope, a box with two mirrors on it," he says.

In the end, Schultz jokes, one of the most difficult parts of the project was getting reimbursed: "Think about it. I submitted a receipt that says Toys 'R' Us."

Tona Kunz

Photo: Reidar Hahn, Fermilab