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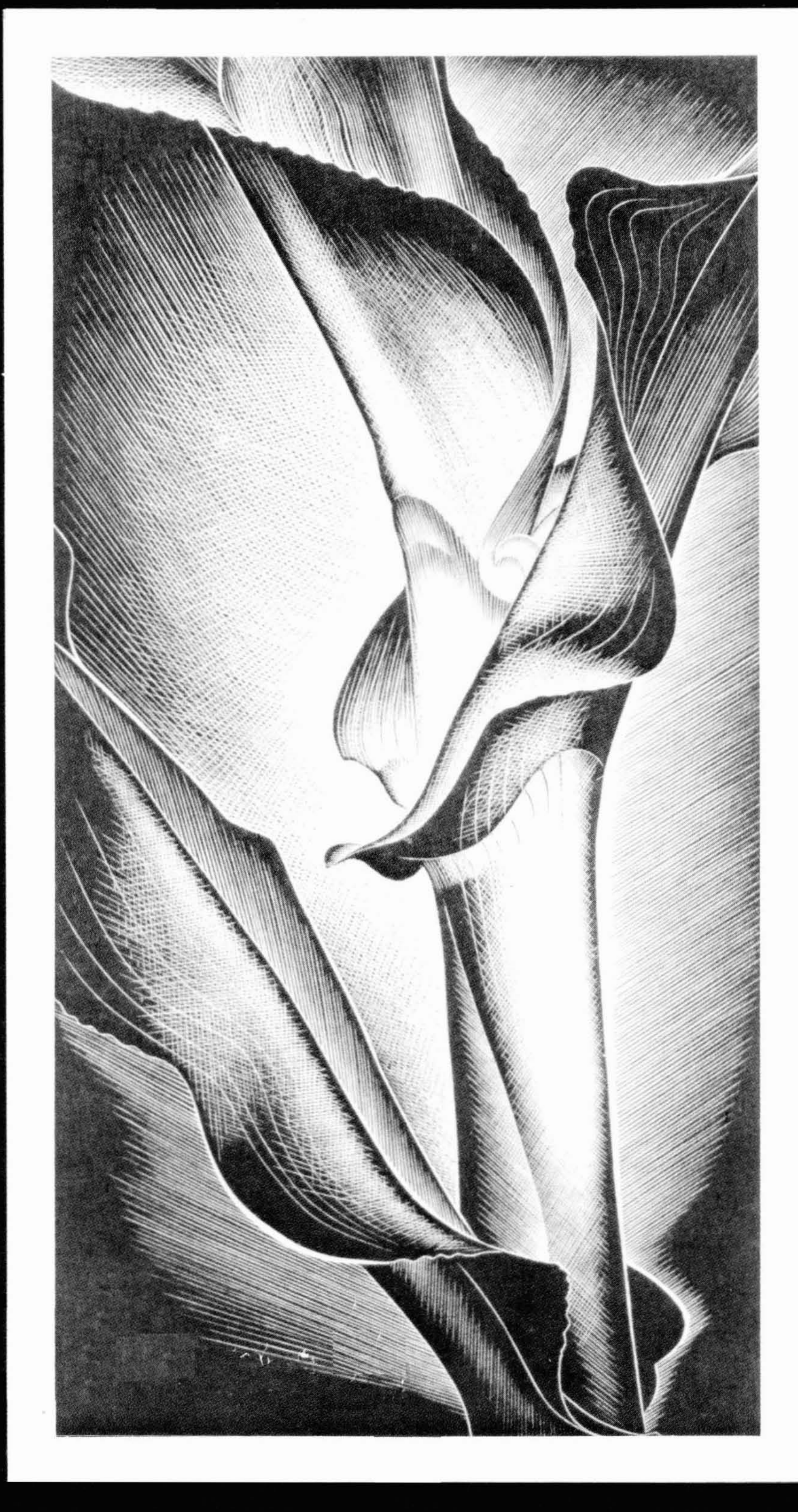

The Grace of Grasses

Conflict and cliff-hangers

The prehistoric cliff dwellings of the Anasazi Indians were discovered in the southwestern United States around a century ago and have intrigued anthropologists ever since. Some have suggested that drought and other environmental pressures forced the Anasazi up the canyon walls, closer to dwindling water sources, in the late 13th century. But recent discoveries by anthropologist Jonathan Haas of the School of American Research in Santa Fe, N.M., and his co-workers support another scenario: Some mesa and cliff sites were defensive outposts meant to protect one group of Anasazi and their scarce resources from the warfare that once convulsed the region.

Last summer, Haas and his research team uncovered in northeastern Arizona two large pueblos constructed by a group of Anasazi known as the Kayenta. One site was accessible only through a crack in the sandstone wall of a 900-foot butte and contained a 200-room pueblo. Another 30-room dwelling was located in a rock shelter at the top of a 140-foot cliff. In the past four years, says Haas, 15 Kayenta cliff sites have been found. Recovered artifacts indicate that the dwellings were inhabited from around A.D. 1250 to A.D. 1300.

The settlements, notes Haas, are in "extraordinarily inaccessible locations" and grouped in visually connected clusters that would have allowed for communication between sites. The pueblos contain large storehouses with the remains of various foods. Some Anasazi groups, unprovoked by warfare, dwelt in cliff houses for centuries. But Haas says the Kayenta apparently abandoned villages on open sites to protect themselves. He proposes that conflict and raids by neighboring groups arose as a result of population expansion, soil erosion, drought and a lack of arable land.

"Conflict and war were the last resort of populations undergoing environmental stress," says Haas. "The Kayenta seem to have been protecting their resources with defensive sites." Around A.D. 1300, he adds, they abandoned the 500-square-mile region now under study, probably because of the combination of environmental deterioration and intense warfare.

A satellite for Machu Picchu

In the Andes Mountains, a graduate student from the University of California at Los Angeles, working with a Peruvian archaeologist, has located the remains of an Inca city from which nearby Machu Picchu can easily be seen. "The city was probably one of many agricultural satellites of a main center at Machu Picchu," says Reinaldo Chohfi of UCLA. Other sites assumed to have once been connected to Machu Picchu have previously been found, but they are much farther from the famous Inca city. The newly discovered site, called Maranpampa, is just across a valley from Machu Picchu, a total distance of about 3 miles.

Chohfi tentatively identified the city after noticing signs of agricultural terraces and "crop" lines in aerial photographs of the jungle surrounding Machu Picchu. He and Octavio Fernandez of the Peruvian National Cultural Institute explored the site in September, locating several stone structures filled with sediment and a massive stone wall – at least 1,000 feet long, 8 feet high and 6 feet thick – probably built by the Incas to protect the city from water and soil runoff from the mountains that jut above it. Several large stone mortars used to grind grain and their accompanying grinding stones were also found.

Excavation of Maranpampa has not yet begun, says Chohfi, and there is no firm date for the site. He estimates the outpost appeared sometime during the period of culture at Machu Picchu, between A.D. 650 and A.D. 1450. Maranpampa and two other nearby cities tentatively identified on aerial photographs have been reported to the Peruvian government, which will oversee further investigations.

Amine absorbers: Chemical time bombs?

On July 23, 1984, workers at an oil refinery near Chicago noticed a leak in a pressure vessel used to remove hydrogen sulfide from propane and butane through an "amine absorption" process. A catastrophic explosion split the 61.5-foot-tall vessel 15 minutes later, rocketing the top 46-foot section more than a half-mile away and initiating a fire. The accident left 17 dead and 17 more injured, and caused more than $100 million worth of damage. A recently completed autopsy of the vessel's remains by the National Bureau of Standards (NBS) in Boulder, Colo., has identified the chemical events that apparently initiated the 1984 explosion – and that may wreak similar havoc at thousands of similar chemical-process vessels elsewhere.

"We learned that hydrogen was responsible," says Harry I. McHenry, the lead NBS investigator – but in ways that were not apparent, either at the start of the NBS investigation or earlier, when a team of private engineering consultants probed the accident's cause. The NBS team found that shallow cracks had developed where repair welds had been made during the vessel's 14 years in service. Hard, brittle steel is susceptible to hydrogen-stress cracking when it's simultaneously subjected to hydrogen – here supplied by the hydrogen sulfide in the vessel – and high internal pressures. Unlike the vessel's original factory-welded seams, McHenry says, affected repair welds had not been tempered (heat treated upon finishing) to make them soft and ductile.

Once the initial cracks formed in the weld-embrittled steel, another process took over – hydrogen-pressure cracking. Hydrogen collected at the crack sites until it built up enough pressure to fracture the material. Repeated over time, McHenry says, this process extended the 1- to 2-millimeter-deep cracks until they penetrated the 25-millimeter-thick vessel walls. Conventional wisdom would suggest that such wall-penetrating cracks would leak indefinitely; instead, McHenry's team found that the embrittlement caused the vessel to split in two.

On the basis of these findings, the NBS team recommends:

- using low-hydrogen welding techniques for repair work because, McHenry says, cracks can form – even if the weld metal wasn't embrittled – if too much hydrogen is used in welding.
- preheating weld areas (to slow weld cooling) and tempering completed welds.
- surveying vessel walls periodically with techniques like "magnetic particle inspection" to find cracks.

In a letter sent to regional Occupational Safety and Health Administration (OSHA) administrators earlier this year, the agency's field operations director, John B. Miles Jr., noted that preliminary results of a survey by the National Association of Corrosion Engineers "indicate that approximately 60 percent of 24 amine absorbers exhibited cracking." A Japanese survey he cited found that 72 percent of amine gas treatment facilities showed cracking. Miles recommends that warnings on the "potentially hazardous circumstances relative to amine-absorber units" be shared with local OSHA offices, state health and safety agencies and refinery owners.

Helping citrus tough it out

Immature citrus peels shield against fruit fly attack – but only to a point. For a while, oils in the peels kill fruit fly eggs and larvae; the toughness of these peels also discourages fly attack. However, as it ripens, the peel softens and its oil content diminishes – signaling the flies to come and feast.

Now scientists at the Agriculture Department's Insect Attractants, Behavior and Basic Biology Lab in Gainesville, Fla., report laboratory tests showing a partial solution: spraying fruit with gibberellic acid, a natural plant hormone, before the fruit turns from green to its ripe color. This, they say, maintains the tough peel – and fly resistance – in ripening fruit.