

Underground Elephants

In one of Africa's least-known spectacles, elephants make their way into the bowels of the earth to mine rich volcanic ores

ARTICLE AND
PHOTOGRAPHS
BY IAN REDMOND

Below: Through the depths of Kitum Cave in Kenya's Mount Elgon National Park, a group of African forest elephants feel their way to the salt mines. Right: After a night of tusk-ing and snoozing, they emerge through a dusty mist to greet the dawn.

THE CRUNCHING was clearly audible. Ten yards away in total darkness, massive molars were grinding rock. With a dim pen torch I cautiously cast a stream of light over the jumbled boulders. Fifteen elephants, standing side by side like coves in a byre, were munching on lumps of rock; overhead, fruit bats flapped off into the night from the fossil branches of their roost.

The setting for this unlikely scene was a cave beneath the forested slopes of an African volcano—my home for a total of five months during the first study of elephants underground.

Elephants are not renowned for burrowing, but there is one place on Earth where they penetrate the dark-





Worn tusks signal the miners' occupation as clearly as employee badges. Babies learn the trade by observing their elders.

est recesses of complex caverns. That place is Mount Elgon, on the Kenya-Uganda border.

ELAGON is one of the many volcanos that punctuate the 3,000-mile-long Afro-Arabian rift system. Stretching from Mozambique to Syria, this series of rifts was formed by movements within the earth's mantle, causing the crust to rupture. Between long parallel faults, equally long chunks of bedrock sank, leaving flat valley bottoms between steep escarpments. In some places lava leaked through the cracks in the crust, creating the solitary volcanic peaks we see today. Some are still active but most lie dormant—sleeping giants with only geothermal springs and steam vents to remind us of their turbulent past.

At 14,178 feet, Mount Elgon is not the highest of East Africa's solitary

Before getting involved with cave elephants, Britisher Ian Redmond spent more than two years doing research and conservation work with mountain gorillas in Rwanda and Zaire. He joined Operation Drake in Papua New Guinea to collect reptiles and amphibians for the British Museum (Natural History). Ian writes and lectures on a free-lance basis and for the BBC.

mountains; it is dwarfed by Kilimanjaro (19,340 ft.) and by Kenya (17,058 ft.). It is, however, the biggest in terms of bulk; the basal diameter—some 50 miles across—has led to speculation that this eroded shallow cone might once have had the highest summit in Africa.

During its formation 10 million to seven million years ago, in the late Miocene, Elgon was behaving much like Mount Saint Helens, in Washington, today. Sudden violent eruptions were interposed with long quiescent periods when forests grew on the slopes. Explosions would flatten the trees for miles around and a rain of pyroclastic material—volcanic bombs, ash, and debris—would be thrown out by the force of the blast.

Most of Elgon is made up of agglomerate produced in this way; only one percent was formed by lava flows. Once on the surface the lava cooled quickly, forming hard, fine-grained basalt layers which, when re-exposed millions of years later, formed a protective cap over the softer material beneath it. Unprotected pyroclastics have been eroded away so the downhill edge of this basalt umbrella usually forms the lip of a cliff. It is into these cliffs that the majority of Elgon's caves extend, the roof sup-

ported by the harder lava cap.

Unlike the spectacular lava tubes beneath other Kenyan volcanos, the caves were not formed in molten rock, but in the softer, underlying layer of mineral-rich agglomerate. Deep within the caverns, the petrified trunks of Miocene trees can be seen radiating from the mountain in the direction of the blast that felled them.

Calcite and zeolite crystals have replaced the wood fibers, and in places the claws of roosting bats have exposed the petrified roots and branches so that, 10 million years after their death, the trees again support life. Fossilized hollow stems and logs are lined with needles of natrolite, looking like glassy crystalline fur. Around the cave mouth these tubes in the rock are used as ready-made nest holes by swifts and swallows. Chicks are reared in soft nests of pale green old-man's beard lichen in crystallized seclusion well beyond the reach of predators.

But the caves are not used just as roost and nest sites. The force that drives elephants underground is their hunger for salt.

All animals need a balanced intake of mineral salts, and if there is a deficit they will go to great lengths to correct it. In mountainous areas of high

rainfall, soluble salts are leached from the soil; vegetation growing in that soil therefore contains low levels of such salts. Herbivores that feed on these plants must find an alternative source, usually a mineral-rich outcrop, which becomes a salt lick.

It is not by accident that in montane rain forests, lodges such as the Ark in Kenya's Aberdare National Park, are built beside natural licks. Visitors there can watch concentrations of shy forest animals: Herbivores are drawn by the salt and carnivores by the herbivores. The predators show no interest in licking rock—their food comes already salted.

At Mount Elgon the soft agglomerate, shielded by its lava umbrella from the leaching effects of rain, contains more than 100 times the sodium salts found in forest plants. The rock is not salty to our palate because it is not sodium chloride (common salt) but sodium sulfate. Known to pharmacists as Glauber's salt—after Johann Rudolf Glauber, the seventeenth-century German chemist who first prepared it—sodium sulfate is dispensed by doctors as a mild laxative, but the copious quantity of dung carpeting the cave floor dispels the notion that visiting elephants are constipated! Not only elephants are lured by the vital sodium ions; buffalos, antelopes, even black-and-white colobus monkeys also make their way into the bowels of the earth.

MY INTRODUCTION to these caves came in 1980, when I visited them as a zoologist with Operation Drake—a two-year circumnavigation of the globe to mark the 400th anniversary of Sir Francis Drake's voyage. The expedition—sponsored by industry and commerce as well as individual donations—combined youthful enthusiasm and military logistics to undertake scientific research and conservation and community projects with international teams of volunteers.

Our task on Elgon was to build a tourist path up to Kitum Cave (one of three caves open to the public in Mount Elgon National Park) so human visitors would not have to share the elephants' route. In addition, we monitored the cave for several nights, and on three unforgettable occasions

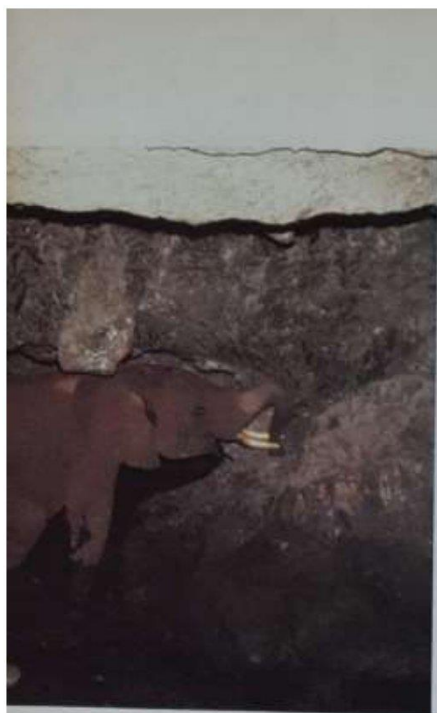
we were lucky enough to see the shadowy shapes of elephants feeling their way into the entrance chamber.

Our observations were limited. Not wishing to alarm the animals, we refrained from using torches (later I discovered they would tolerate a small

penlight beam). Crouched on a rock, ears straining in the dark, my imagination was fired by sounds: the whoosh of air blown down a trunk, the scraping of pachyderm on rock, the low rumbles of contentment that reverberated around the cave, and, some-

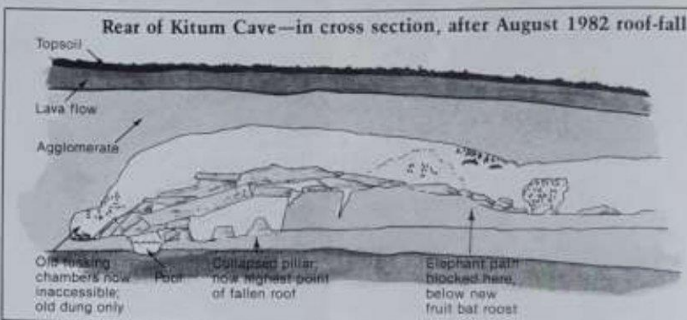
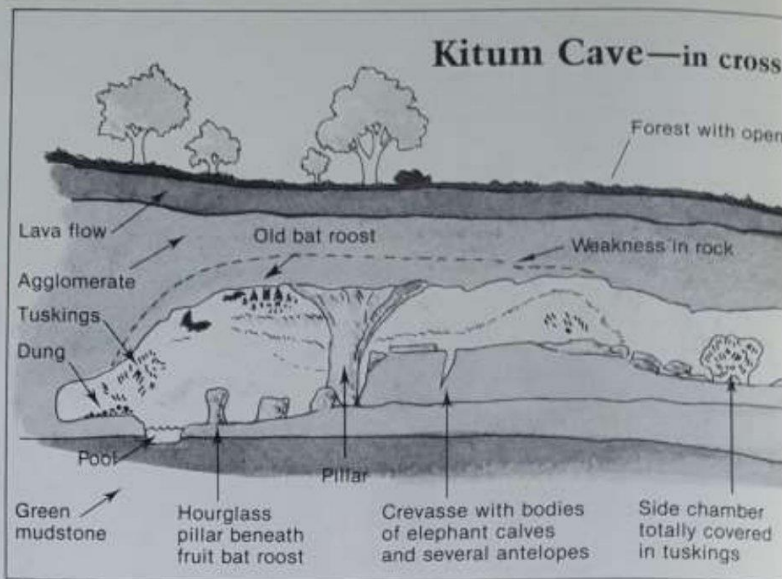


At Mackingeni, another of Elgon's wildlife-nourishing salt caves, water cascades over a 52-foot-high entrance arch. Three caves are open to the public.



Above: The mining is laborious, for elephants cannot lick or bite the rock as other animals do. With their tusks they pick and heave at irregularities in the wall and with their trunks try to catch the loosened rock before it falls into the mud; then they grind it with their molars . . . and swallow.

Right: In 1982 the rear third of Kitum collapsed. Massive roof slabs piled on the floor make easier pickings, but, in the dark, jagged edges and crevasses are very hazardous.



Diagrams by Jan O'Connell, after Ian Rudmont

times, the discordant trumpeting that filled the cave with solid sound.

Like Rudyard Kipling's *Elephant's Child*, my "'satiated curiosity'" was aroused and "ever so many questions" sprang to mind. Surprisingly, there were no answers as no one had studied the phenomenon. It was well known to local residents that the elephants on Elgon went caving (the logo of East Africa's Cave Exploration Group is an elephant emerging from a cave), and it was presumed they were tusking for salt. Beyond that not much was known. Since my first visit I have made five field trips to Elgon, assisted at different times by my wife, Caroline, and others, and have managed to throw a little light—literally

and metaphorically—on the world's only troglodyte tuskers.

KITUM CAVE, the focal point of my research, is typical of the many caves hidden in the forested folds of Mount Elgon's fertile flanks. Situated at the head of a small valley at an altitude of 7,900 feet, it is regularly visited by elephants and other herbivores. The cave mouth, shaped like an irregular letterbox, is 45 yards wide and mostly blocked by fallen rock and a waterfall cascading over the cliff. Inside, the cavern widens to more than 100 yards and extends more or less horizontally into the mountain for 175 yards.

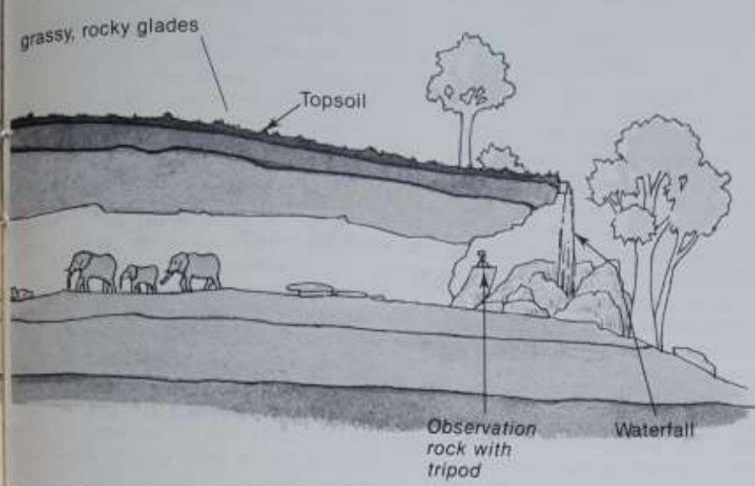
Much of the floor consists of

mounds of fallen roof over which the elephants must clamber to reach the salt-mining bays. The worked walls are covered with a crazy mosaic of tusks—smooth grooves carved in the rock by living ivory chisels.

For my base of operations I selected a large rock shaped like a ship's prow, jutting from the north wall just inside the entrance chamber; behind this I placed my bed—a mattress borrowed from Elgon Lodge.

To the left of my campsite the waterfall splatters onto the mossy jumble of rocks that blocks most of the cave mouth. Forty-five yards ahead the south wall overhangs the narrow path by which all large animals enter and leave. Below the ob-

section, prior to August 1982 roof-fall



servation rock some of the water splashes and gurgles through the boulders and down the valley; the rest flows back into the cave, creating a large muddy area pocked with elephantine footprints.

In the tranquility of the early morning, with sunlight streaming through the crystal-clear cascade, hyraxes would stretch and sun themselves on the rocks, and the water-filled footprints would send shimmering reflections dancing about the roof of the cave. Apart from occasional trips down to Kitale market for supplies, my policy was simply to live in the cave and monitor all traffic.

In general, the elephants were remarkably tolerant and once they had accepted the presence of harmless human company, they paid me little heed as long as I kept a low profile.

They usually arrived at dusk, feeding leisurely before disappearing, single file, into the black maw of Kitum main cave. The cows kept maternally trunks on their young to prevent their straying near a crevasse that previously had claimed the lives of two calves and several antelopes. Once in the back chamber they would relax, spread out, splash in the pools, and mine the rock, staying up to six hours or more, apparently at ease in the stygian blackness.

Sometimes the night would be shattered by a discordant trumpeting that filled the cave with solid sound.

At that time of night a torch shone onto the domed roof above them would reveal a moving squealing galaxy of reflective red eyes: the roost of Rousseau's bats preparing for another night's foraging in fruit trees.

Unlike most other species of fruit bats, which navigate by sight, Rousseau's bats have evolved a primitive tongue-clicking sonar system for night flying—not a patch on an insectivorous bat's system but sufficient to get around the cave. During the late-evening fly-past, one could just discern the *tut-tut-tut* of their sonar and occasionally feel the waft of a two-foot wingspan.

So as not to miss an elephant visit, I would sleep tied to a length of black cotton thread stretched over the entrance path at elephant head height. I devised this simple alarm to overcome the problem of missing their often silent approach whilst I was either

asleep or just waiting in the dark next to a noisy waterfall. But the thread did not go unnoticed.

The dermal layers of an elephant's forehead may be up to an inch or more thick but they are very sensitive. Photographs later proved what I had begun to suspect: The leading elephant sometimes felt carefully along the thread to where it was tied to the wall, then neatly snapped it off as I slumbered on. Usually I heard them once in the cave but missed recording their time of arrival.

One evening an old solitary bull I called One-Tusk Willy touched the thread and let out a roar of frustration. Hours later he returned and repeated the performance but in the morning the thread was still unbroken. Perhaps he had somewhere experienced the new solar-powered electric fencing that discourages elephants with long memories from following traditional routes through rich farmland.

Crop raiding (as man terms it) is a problem. While searching elephant dung for rock particles, I often found undigested grains—evidence of the animals' predilection for wheat and maize. When elephants came up to the cave after a raid they were more nervous than usual.

FOLLOWING THE ELEPHANTS and observing things never seen by human eyes were the high points of my study, but success did not come easily. In 1981 Caroline and I lived in Kitum for six weeks, but for the first three and a half weeks no elephants turned up.

It was the end of the rainy season—cold and damp—and our spirits sank almost as low as the gray clouds that added daily to the waterfall and drips in the cave. During the fourth week the rain decreased and a few sunny days dried the forest (and our kit) a little. On our twenty-fifth night, at 8:20 P.M., the cotton tugged twice and broke: Our observations began.

After shooting half a roll of infrared film with invisible red flashes, we were ecstatic to find that the elephants continued into the cave. (Our joy might have been tempered somewhat had we known that the humidity had already destroyed that roll.)

For the first time, I followed the elephants into the back chamber,

keeping to the route least accessible to blindly wandering pachyderms. A bat circled above me, clicking, and I could hear heavy breathing and the clunk of tusk on rock, but I still couldn't see an elephant. The huge boulders I had mapped began to look alarmingly like elephant bottoms and flanks; determined to see a *real* underground elephant, I moved to the pillar that supported the cave roof and waited. There, in the light of my pen torch, it happened. An elephant head slowly appeared round the pillar. It was a young bull. As if in slow motion he glided past within 10 yards, then up onto the mound, where he paused for several minutes before heading out to the forest.

That image remains indelibly imprinted on my mind. It was only then that I realized just how helpless the elephants are when negotiating such an obstacle course in darkness. With

trunks outstretched like built-in white canes, the beasts carefully place each foot before lifting the next; groups move in single file like circus elephants, the one in front feeling the way and the rest following nose-to-tail behind. It is literally a case of the blind leading the blind, yet they seem quite familiar with the layout of the cave and relaxed even in my presence.

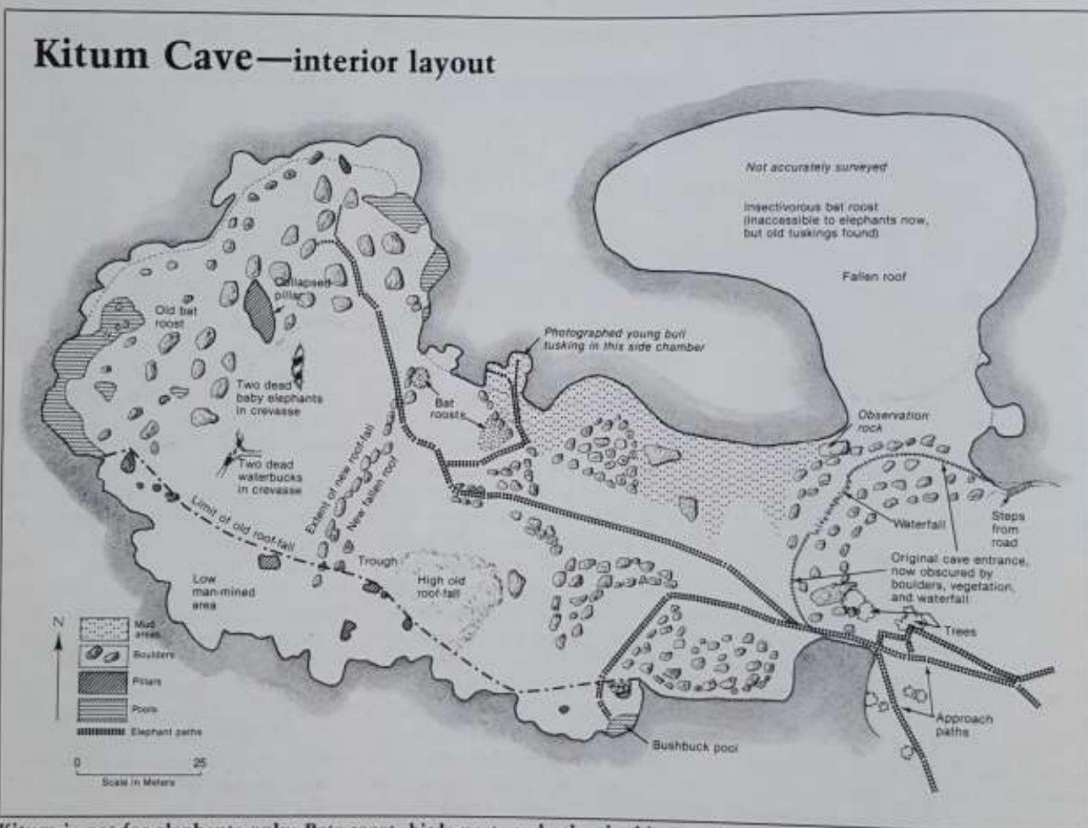
One night I watched a calf suckle her mother beneath the fruit bat roost while, nearby, the herd matriarch rubbed her rump contentedly on a convenient rock. Another time a young bull, unfettered by family ties, allowed me to approach within several yards of where he was mining before spreading his ears at me in annoyance. His mining technique was straightforward: place tusk on irregularity on wall and heave; try to catch loosened rock before it falls in mud.

Loosening lumps is obligatory for

an elephant because it cannot lick or bite the rock as most other animals do. With tusks and trunk there is just too much tackle obstructing the mouth. As with every other food item, rock must be placed in the mouth with the prehensile trunk tip, ground by the molars, and swallowed.

The results of this mining are clearly visible on the walls and lower ceilings of worked chambers. Five or six tons of pachyderm pushing on the point of a tusk produces a stripe of polished rock—a tuskings—which remains for many years. In old caves, now blocked by rockfalls or surrounded by agriculture outside the park, tuskings provide mute testimony to the efforts of earlier elephants.

But the miners pay a price for their ration of salt. Although tusks (modified incisors) grow throughout life, most adult elephants on Elgon have worn theirs down to short rounded



Jim O'Connell, after I. Hedmond and M. Carter

stumps, some barely protruding beyond the bases of their trunks. Most affected are the cows, as they need more salt when pregnant and lactating. In these extreme circumstances, tusk growth cannot keep up with wear.

The elephants do, however, seem to enjoy the caves (one female was even caught by a flash photo taking a dust bath) otherwise why would they stay so long underground?

Elephants spend about 80 percent of each 24 hours feeding, so five or six hours in a cave makes a large gap in the daily cycle. Tape recordings of their activity in the dark revealed that they are not mining all that time. After a while there is just silence, broken by occasional resounding flatulence. Apparently they like to sleep underground after their dose of salts. At this altitude night temperatures outside can drop to below 46°F, but the cave interior remains a constant 57°F with 85 to 90 percent humidity. With salt rock and pools of water to boot, it is not surprising the elephants should choose to relax in troglodyte comfort.

EVER SINCE Scottish explorer Joseph Thomson visited Elgon, in 1883, the origin of these remarkable caves has been a subject of speculation. Conventional theories of cave formation, such as splashing waves, underground rivers, and gas bubbles trapped by lava, fail to account for their characteristics.

Some theories have even suggested that they are man-made, as the El Kony (the mispronunciation of which gave the mountain its European name) tribe, sometimes called the Elgon Masai, formerly inhabited the larger caves along with their cattle. They mined basketfuls of rock for their stock (and still do in one or two caves outside the park boundary) but the idea that their primitive tools could have created such impressive caverns has been scoffed at. Pastoral man probably moved into ready-made caves. There is, however, an alternative if rather unorthodox explanation of their origin.

Long before man began keeping cattle, elephants and their proboscidean progenitors roamed these forests. If we reflect upon the effect of generations of elephants, each in need of a regular peck of salt, the origin of the caves becomes apparent.

*A bat circled above me,
clicking, and I could
hear heavy breathing
and the clunk of tusk
on rock.*

Examination of 15 different-sized caves revealed the stages in evolution and decay of an elephant cave. Most exposures of mineral-rich agglomerate on Elgon show signs of tusking, but only where they have been softened by waterfalls does erosion by tusk have an appreciable effect. Initially this causes shallow caves and overhangs similar to those reported in India, Sumatra, and Tanzania's Ngorongoro Crater. Such overhangs collapse periodically, giving the long-term effect of a receding cliff. But on Elgon the cliff is capped by a layer of lava, enabling the cave to extend deeper and deeper as each generation of elephants continues the work.

During their long childhood, calves must learn all the features in their home range, the whereabouts of salt licks are part of the cultural knowledge of an elephant herd. Even though the caves grow deep enough to have a dark zone, the change is so gradual that each generation sees it as the norm. The enlarging cave's shape would be affected by patches of softer rock and by rockfalls, which can create mounds with crevasses to trap the unwary or even block a chamber completely.

When I began my study, and for as long as anyone can remember, the roof of Kitum Cave was supported at its widest point by a huge rock pillar that was gradually being tusked away (see diagrams, pages 34 and 36). One night in July 1982, local farmers awoke to feel a slight earth tremor, soon afterward, the whole back third of Kitum was found to have collapsed.

Where the pillar once stood, a pile of massive slabs now forms the highest point in the cave. Already, elephants are clambering onto the mound in search of new mining sites—an extremely risky business in the dark. One slipped, became stuck, and had to be shot by a park ranger to prevent

a slow agonizing death.

The freshly broken slabs, however, make easier pickings and large quantities of rock can be consumed without slow tedious mining, which illustrates how elephants can increase the height as well as the depth of a cave. The highest tusk marks were only 13 feet up the wall, but huge domed chambers develop when repeated roof-falls are carried out in the stomachs of salt-hungry elephants.

Just south of Kitum is a valley that shows the final stage—a completely overgrown collapsed dome with only the rear chambers accessible through cracks in the now concave roof.

But these caves are huge, some people protest. How can elephants possibly remove so much rock? The answer: Slowly. Forty-five percent of the elephant droppings examined during this study contained rock fragments, some as large as two inches across.

The volume of Kitum Cave is on the order of 1.3 million gallons. If, for the sake of conservative argument, we suppose that elephant excavations averaged just one quart per week, it would have taken only 100,000 years for them to dig Kitum. And that is without the help of other animals and pastoral man. Given that Elgon has not erupted for several million years and that elephants have been around for about two million years (to say nothing of their tusked ancestors), the theory of elephant speleogenesis is entirely plausible. The caves of Mount Elgon are the world's only elephant salt mines.

As with most research, each new and fascinating fact raises more and better-phrased questions. My "satiated curiosity" is not yet sated so we plan to do further work. Funds permitting, we hope to radio-track elephant groups to discover where they obtain their salt when not visiting Kitum. Does their need for salt vary according to season? Do different herds use different caves or whichever is nearest? Can we quantify the amount of rock eaten per visit to accurately calculate the annual rate of excavation?

Regardless of whether the mysteries are solved, the wonder of elephants feeling their way deep underground will live on in the mind of anyone lucky enough to see them. □

Animal Kingdom®

THE ZOOLOGICAL SOCIETY MAGAZINE



There are countless questions about sea turtles but few answers so far.

Page 11

ABOUT THE COVERS

FRONT: Nose to trunk with an elephant!! In a cave!! Not so far-fetched as one might think. In East Africa there are some spelunking pachyderms, who go underground to mine their salt rations. See page 30. (William Conway, NYZS)

BACK: Sights like this nesting aggregation of olive ridleys on a Costa Rican beach have not been seen for years and never will be. This sea turtle is on the decline. All its kin are in trouble too, and science has barely begun to know the creatures. See page 11. (David Hughes)

FEATURES

BY ARCHIE CARR

11 Secrets of the Sea Turtles

How do sea turtles navigate in vast open waters? Where do the babies spend their first year? Scientists still ponder these and other turtle mysteries

PHOTOGRAPHS BY
HENDRIK LOURENS

19 Don't Go Near the Water

A too-close encounter between a giraffe and a crocodile

ARTICLE BY CHRISTINE
SHEPPARD

20 A Yardful of Penguins

Forsaking the sophistication of Buenos Aires, the Passera family opted to live for a time among a million braying penguins on a desolate wind-swept spit of land

PHOTOGRAPHS BY
CARLOS A. PASSERA

ARTICLE AND PHOTOGRAPHS
BY IAN REDMOND

30 Underground Elephants

In one of Africa's least-known spectacles, elephants make their way into the bowels of the earth to mine rich volcanic ores

BY BRUCE ALLAR

38 Smallest of the Small

Like so many Gullivers among the Lilliputians, researchers probe the lifestyle of pygmy shrews

ARTICLE AND PHOTOGRAPHS
BY JOHN R.H. GIBBONS

40 On the Trail of the Crested Iguana

Having discovered a new lizard, the author tries to find more specimens and learn about the creature's biology

DEPARTMENTS

2 Animaline

Hope for Siberian cranes
New killer whale facility
First jaguar sanctuary
Uganda national park
Sea worms

5 Images

Television—Nature Series

6 Medical Center

ILC: Intensive Loving Care
BY EMIL P. DOLENSEK WITH
BARBARA BURN

8 Bones

The Making of the
Mammals
BY JOHN C. MC LOUGHLIN

46 Not-So-Wild Animals

I Have Known
Baby Doo
BY JACK L. THROP

51 Index 1984, Volume 87