AWASH WITH FOSSILS

The Afar region of Ethiopia is littered with traces of the earliest humans. **Rex Dalton** gets on the trail with a team of devoted experts who just live for the next find.

R. DALTON

Into Africa: Berhane Asfaw has devoted two decades to unearthing Ethiopia's treasures.

Ethiopians have a peculiarly fitting saying about the remote province of Afar — it is 'where it all began'. Isolated in the harsh region is a low ridge that has brought to light humanity's beginnings, by providing a wealth of fossils.

In early December, under the glare of a near-equatorial sun, an international team of palaeoanthropologists scours sediments on the ridge for fossil bones, teeth or artefacts; the researchers have worked here for more than 20 years. Five years ago they identified a site called Asa Issie, or 'red hill', as promising ground after unseasonable torrents trapped them in the area. This year they have returned to see what has surfaced after summer rains swelled the nearby Awash river.

At times stooped, sometimes crawling, but always focusing on the sea of stones that cover the ground, the crew spreads slowly through ravines. Alongside the scientists are locals, whose sharp eyes and self-taught knowledge make them integral to success.

First come fossils of rhinoceros (*Ceratotherium*) and kudu (*Tragelaphini*), bones that provide insight into the region's former environment. Then a shout pierces the afternoon wind: "Canine!"

A cream-coloured hominid tooth, about 4 million years old, has been spotted among the white pebbles. It is only the third day of a month-long field season, and this discovery marks the 13th consecutive year that the team has found hominid specimens. Later, as the sun sets over the mountains to the west, team co-leader Tim White says to me: "There is no other spot on the planet like this. It is a special place."

There is also no other team like White's. Year after year, the Middle Awash project has identified some of the most important hominid specimens, including one of the oldest *Homo sapiens* and the 5.8-million-year-old *Ardipithecus kadabba*¹⁻³. As other palaeoanthropologists have sought older and older hominids — and the fame that comes with such discoveries — the Middle Awash team has shone by identifying new hominid characteristics that flesh out the evolutionary track from ape to man.

Much of this success can be traced to the project's multinational roots. It represents the

best of scientific capacity-building: African scientists receive doctorates at top universities overseas, and then return to work and nurture projects at home. Scientists from abroad, such as White — at the University of California, Berkeley — are in the minority. The team's other leaders are Ethiopians: there is Giday WoldeGabriel, a geologist at the Los Alamos National Laboratory in New Mexico; the palaeoanthropologist Berhane Asfaw, director of Ethiopia's National Museum in Addis Ababa; and Yonas Beyene, a government archaeologist. Yohannes Haile-Selassie, a key team member who received his doctorate at Berkeley, like Asfaw, is curator of physical anthropology at the Cleveland Museum of Natural History in Ohio, a bastion of hominid research.

Postdocs and students come from France, Lebanon, Turkey and the United States. Everyone eats at the same table; team leaders shovel dirt just like the others. White drives the team hard, but junior scientists thirst for his feedback. One night, postdoc Michael Black — a specialist in hominid biomechanics who doubles as the camp solar electrician — waits so long for White's last instructions that he falls asleep at the dinner table.

The hominid tooth was found by Ferhat Kaya, a graduate of Turkey's Ankara University who studies minuscule mammals. Desperately working on his English skills to get on a US doctoral programme, Kaya beams when White gives him a complimentary high-five and tells him: "Good job, Ferhat." And everyone is pleased that the trip's first hominid discovery is made by the only trained scientist in the crew who is Muslim. "Fantastic," says Asfaw. "It shows the international aspect of the team."

Every year, the Middle Awash team ventures into the field in November or December, when the climate is most suitable for exploration. But rains still come. Once, a French researcher desperate to leave escaped by hiring Afar tribesmen to pull him on a raft to the asphalt highway.

Political upheavals have also threatened the project. Fieldwork stopped during most of the 1980s because of domestic turmoil and the writing of new antiquities laws. This year, David Perlman of the *San Francisco Chronicle* and I went to join the team, the first time journalists have been allowed to come along since its explorations began in 1981.

The Afar fossil ground is only about 250 kilometres northeast of Addis Ababa, which is located in the highlands near the centre of the country (see map). But the journey down to the Middle Awash site is a gruelling and dangerous three-day drive, and the crew has to make its own way along the final stretch on to a ridge known as Bouri.

Scene from Afar

The arid land is dotted by small villages of crude huts, often abandoned when the herders seek fresh grass. To me, the hamlets seem little changed from earlier eras, but today's Afar lifestyle might be better described as 'Neolithic, with Kalashnikovs'. Virtually every herder carries one of the Russian rifles, and some are equipped with rocket-propelled grenades.

The Afar are fighting another tribe, the Issa, which pushed north from Somalia seeking grazing lands. Daily, the palaeoanthropologists seek intelligence to avoid potential fire-fights. Armed policemen accompany the team at all times, as do Afar sheikhs and leaders, such as tribal chief Hamed Elema — who has himself become a skilled fossil finder. A year ago, the team had to abort a trip to date new hominid specimens because a gun battle threatened.

Last month, nine heavily loaded, all-wheel-drive trucks moved northeast out of Addis Ababa, through the Awash river valley and to the Bouri 'peninsula' — so named for its shape on the satellite images used to find sites. The drive features spectacular views of the mountains created by tectonic action along the African rift zone. The rift runs along the east of Africa; in the Afar region, the Arabian and Somalian plates pull east and away from the Nubian plate, causing giant blocks of crust to shift.

Standing on the Bouri ridge, looking west

toward the rift margin, the mountains resemble giant stairs: whole sections have dropped down after the tectonic expansion. To the north, the blocks have shifted and twisted, creating a complex geological terrain of ridges. To the south is Yardi Lake, a water-filled depression full of crocodiles and hippos.

Rain washes the edge of the mountainous blocks, exposing fossils of various ages. But dating the specimens is an onerous chore. It can take weeks of arduous hiking to collect samples for geochemical testing. The easiest and best way to find a fossil's age is to date a volcanic tuff layer above or below it. However, when the tuffs have been altered by weather and time, they produce no datable signature. Then geologists must correlate fossil-bearing layers with distant sediments whose ages are already known.

It took several years, for instance, for WoldeGabriel and Haile-Selassie to determine the age of the *A. kadabba* specimen⁴. "The geology is still ongoing," says WoldeGabriel. "I need to go and check some of the more complex faulting."

The remote treks put even Ethiopians in personal peril. In the late 1990s, when Haile-Selassie and WoldeGabriel were exploring the region near a sacred village, an offended Afar tribesman chased them away. "He kept his Kalashnikov on us," recalls WoldeGabriel. "It didn't make any difference that we were Ethiopians."

The work was worth it, though. Their 2001 article showed that the hominids — then the earliest known — lived in a wooded environment, not a savannah as previously thought.

On the Bouri peninsula, just a short drive is needed to reach interesting sediments. The early *H. sapiens* was found on the ridge, and a 1-million-year-old *H. erectus* was uncovered near the Bouri hamlet⁵, also called the 'hyena condominiums' because the beasts occupy the caves, bursting out when the team starts exploring. A 2.5-million-year-old *Australopithecus garhi* was discovered⁶ just where the ridge descends to the Awash river — a site that is known for extremely early evidence of stone-tool cuts on antelope bones. And just across the river is the Maka site, where the team discovered the 3.4-million-year-old *A. afarensis* that sparked one of its first major publications⁷.

Bouri is starkly different from the famous Hadar location, home to the 1974 discovery of the *A. afarensis* skeleton known as Lucy⁸. Just 70 kilometres to the north, Hadar is rich in hominid fossils — but they all come from the

"Back at the trucks, a girl waits with an elephant tooth. White jokingly suggests our police guards arrest her, and she is asked to return the fossil to its location."

R. DALTON

Collector's lot: Tim White (right) has found many of the fossils that will grace the new palaeoanthropology wing of Ethiopia's National Museum.

R. DALTON

same time period, 3 million to 3.5 million years ago. Bouri, in contrast, contains varied ages and species, which help palaeoanthropologists to understand the evolving features of man.

To sort through all this material, the Middle Awash team has devised sophisticated collection methods⁹. In one, 'the crawl', the researchers mark a promising area with surveyors' lines, then crawl across it shoulder to shoulder, removing every fossil found. Later comes 'maintenance', in which they return at various intervals to see what else has eroded from the plot — if fossils aren't found shortly after being exposed, they disintegrate.

With field time valuable, White is trying an experiment to determine the most efficient way to monitor sites. He planted 200 casts of fossils at an Awash site. The crew will return periodically for maintenance; by seeing how many casts are found, White hopes to determine how often return visits are needed if nothing is to be missed.

Such care underscores the long-term views of the team. White dislikes what he calls "hominid treasure hunts", where researchers move in for short field visits to grab hominids and then headlines.

For the team, the cataloguing of animal fossils deserves the same care as preserving hominid fossils. During last year's field season, the team collected about 1,400 vertebrate fossils — from elephant bones to the teeth of tiny mammals, which they preserve on waxed pinheads. All are cleaned and stored at the National Museum in Addis Ababa, which holds some 15,600 vertebrate fossils. The Ethiopian government is building a major new \$3.5-million research facility for the museum, and a whole wing will be set aside for the palaeoanthropology collection.

Such repositories help the study of hominids,

whichever team discovers them. For instance, French palaeoanthropologist Michel Brunet helped date the oldest hominid, *Sahelanthropus tchadensis*¹⁰, in Chad using a coexistent pig (*Nyanzachoerus syrticus*) from Ethiopia's collection. The pig species is known to have disappeared about 5.7 million years ago, so Brunet knew his specimen, called Toumaï, had to be at least that old.

Now, a former member of Brunet's team, Jean-Renaud Boissierie of Berkeley, is in the Middle Awash seeking to augment the animal fossil record — particularly that of hippopotamuses. These creatures can provide exquisite detail on dates and palaeobiogeography. They live in water, but species differ among river basins. Boissierie seeks hippo skulls and teeth, from which he can extract carbon-isotope samples and learn about the animals' diet and environment.

Tuff choices

"So what period do you want to examine?" White asks Boissierie on the drive to Bouri, offering him several options. Boissierie selects 2.5 million years. That means the team will head first to the Lubaka site near the Awash river, keeping eyes open for roaming lions.

Largely barren of vegetation, the hillocks at Lubaka reflect the volcanic tuffs used to date specimens. There is also another target today: stone tools. Although the *A. garhi* specimen was found with antelope bones that had cut marks, there were no artefacts. White and Asfaw want to link tools to the hominids.

After an hour and a half of hot walking, Boissierie gets his wish. Team member Kampire Krantu finds a good hippo jaw, with teeth, that is just surfacing in a ravine. Krantu is one of the team's best searchers. He has no scientific training, and no one on the team can

speak his Konso language. But his talent for spotting fossils is legendary.

The team leaders are not so lucky. White spots a black basalt chopper in a hillside. But he rejects it when he notices evidence in the sediments encasing it that suggest it has been washed there from its original location. Finding a tool that is truly *in situ* must wait for another day.

After a week in the field, the team cuts a new road out of the bush, making it easier for supply trucks to come and go. They begin to explore intriguing foothills south toward the rift margin. Hominid fever, however, dwindles when the only find is a giant tortoise fossil.

Back at the trucks, an Afar girl waits for us with a brick-shaped elephant tooth. White jokingly suggests our police guards arrest her, and she is asked to return the fossil to its location. He worries that keeping such items encourages locals to remove fossils from their surroundings, destroying vital geological information.

A week later, the team returns to ensure the fossil was replaced. And there, near the elephant tooth site, they find fresh fuel for their fever — a hominid tooth shard.

Bushels of earth around it will be sieved for any remaining pieces. Tuff dating will follow, then site maintenance. A published article may be years off, but once again Afar shows where it all began.

Rex Dalton is Nature's West Coast correspondent.

1. White, T.D. *et al.* *Nature* **423**, 742–747 (2003).
2. Haile-Selassie, Y. *Nature* **412**, 178–181 (2001).
3. Haile-Selassie, Y. *et al.* *Science* **303**, 1503–1505 (2004).
4. WoldeGabriel, G. *et al.* *Nature* **412**, 175–178 (2001).
5. Asfaw, B. *et al.* *Nature* **416**, 317–320 (2002).
6. Asfaw, B. *et al.* *Science* **284**, 629–635 (1999).
7. White, T.D. *et al.* *Nature* **366**, 261–265 (1993).
8. Johanson, D.C. & Taieb, M. *Nature* **260**, 293–297 (1976).
9. White, T.D. *C.R. Palevol* **3**, 341–351 (2004).
10. Brunet, M. *et al.* *Nature* **418**, 145–151 (2002).