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Kalahari Earthsuckers
San Sip-Wells vs. Roughneck Rigs: Seducing Water from the Ground

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SEPTEMBER 1, 2003

Stage 1 — Attraction

ZUTSWA, Botswana — Wrinkled old Tebere D'ana bit into the burnt donkey head and tore a fatty mouthful from its cheek. Bushmen find meat where they can in this part of the Kalahari. When government-supplied dry goods ran out and wild game eluded their snares, scavenged *tête de jackass flambée* topped the menu. Ditto with fire. When donated matches ran out, Tebere's wife Maselale fished flint from a bag strung around her neck, struck stone to spark, spark to grass, grass to sticks until, minutes later, she picked up embers in her thick fingertips and lit a pipeful of tobacco/marijuana blend.

On that cold morning five more of us — Tebere's sisters Thaleta and Matate, her brother X'uno, their nephew/my translator 'Billy Ocean'[1] and I — joined the old couple huddled around flames on the outskirts of Zutswa Pan. All appetites were sated but thirst. I somehow resisted the donkey brain and hooch pipe, but grew ravenous to see what the clan would do now that water, too, had run out. Last month the Israeli-built micro-desalination pump ground to a halt, lacking spare foreign parts. The government's water tanker was a week late in its delivery. No plastic containers held a drop within 50 miles in any direction; no river

A Lost Art? *Tebere D'ana and wife Maselale are among the last bushmen who still know, and practice, the prehistoric art of using 'sip-wells"*

[1] He didn't know where his name came from, but was delighted to learn that it was identical to that of the hero of a Hollywood heist movie, played by Frank Sinatra, which came out the year he was born.

flowed within 600. And not one of the D'ana clan seemed worried in the slightest.

The laid-back confidence was not simply *dagga*-induced. Tebere assured me he knew a place 'somewhere nearby' where he thought he could inhale water from the sand just as his ancestors had, the same subtle manner his people had over thousands of years before whites and blacks arrived here. It's known as a sip-well. Few outsiders had seen this method; even Bushmen born in recent decades rarely knew of it. The sipwell practice may become — like Japanese Zen calligraphy or New England dry masonry — a lost art.

But not yet. Tebere swallowed donkey lips, smacked his own lips, hobbled the two remaining donkeys, and turned his playful eyes to me. "Let's go."

TUVATJERENI, Namibia— Seven hundred miles north across the border, Lawrence Prinsloo bit off a burnt chunk of cow butt and washed it down with beer. He jabbed two cigarettes between his lips, lit both, inhaled the rich double-dose of nicotine and passed the second to his drilling partner, 'The Englishman,' a.k.a. Milford Brickhill. They too were in the midst of a semi-nomadic hunt for underground water in dry, remote parts of the Kalahari with a self-reliance matched only by the Bushmen.

Granted, they had resources to fuel resourcefulness. But comfort margins wore thin. When beef ran out in the field they opened tins of mystery meat that likely contained donkey. As clamps gave out they forged new ones. A broken 'breakout spanner' — a wrench for decoupling drill segments — was re-rigged with a welder. When a differential collapsed they rebuilt it from scratch. Spending weeks isolated in the bush with the same crew of testosterone-filled men, they'd get cabin-fevered, stressed, sick, jarred, bored, bruised, fatigued, injured, cross, bossy, bitter, dehydrated, sweaty, greasy and at times far more in need of a shower than old Tebere ever was. They recounted how UNITA rebels had fired on them as instruments of Angola's government, and how even dam contractors shot over their heads as competitors for donor and government funds. Malaria was rampant. Women were absent. Pay was lousy.

"I love it out here," said Brickhill.

"No place I'd rather be," added Prinsloo. Then he added, aware of my scribbling notes. "Except, ahem, maybe, at home with my lovely daughter and beautiful wife."

Erect, Set, Drill: *Lawrence Prinsloo at control panels 'hoists the mast' on his mobile drilling rig in the prep stage of punching a borehole in the earth*

Well, hell. If Tebere could haul his family on a water quest, Lawrence Prinsloo might one day, too. Lawrence himself already followed the footsteps of his older brother Kobus, and they'd learned the rugged trade from their father, Willie. In his lifetime the legendary one-eyed driller Willie Prinsloo had single-handedly sniffed out, bored down on, and yanked out more water in Namibia alone than most nations drill in their entire history.

Then again, Namibia (and Botswana) had no choice. Because neither has permanent rivers to call their own, because rainfall averages 250 millimeters, and because 83 percent of that rain evaporates, 14 percent transpires through plants, and two percent runs into ephemeral trickles that last only days or hours, Namibia and Botswana have to search hard to grasp and squeeze that last one percent that infiltrates rock and sand underground and hides in mysterious porous cracks and gaps called 'aquifers.'

In 1903 geologist Dr. Lotz imported the first crude borehole-drilling machine to a land where only Bushmen could extract water from the ground. Exactly one century later Namibia has drilled some 100,000 boreholes, half of which still produce the liquid more precious than oil. Since Namibia has 1.8 million people, that averages 36 individuals for every working borehole. Boreholes alone supply half the homes, three-quarters of the livestock, a third of the mines and a fourth of irrigated farms. But it's still not enough.

Last month the United Nations announced plans

to map and aggressively tap Africa's 20 trans-boundary aquifers to reduce the continent's populations without water and sanitation by 75 percent within the decade. One of those 20 is the Kalahari/Karoo aquifer. Like a trans-boundary river, the aquifer is shared by Namibia, Botswana and South Africa; unlike a river, no one yet has been able to see it, measure it, understand it or, worse, govern it. No laws regulate or monitor the aquifer's use, or abuse. "This legal vacuum can generate considerable misunderstanding and tension," warned UNESCO officials. Countries could scramble to tap as much water as possible before a more powerful neighbor got in on the action. "Transboundary aquifers are therefore potential 'hotspots' or sources of conflict, especially in arid regions where fierce competition for water resources will intensify in the future."

Already the rush has begun. To meet compounding industrial demands, to distribute fairly as much water to blacks as whites got under apartheid, and to develop people away from crowded cities to rural areas, more and more boreholes are sunk deeper and deeper in more and more remote places, like Tuvatjereni.

After Prinsloo and Brickhill complete this U.N.- sponsored Northern Livestock Development Programme (NOLIDEP) contract, they'll shift to the Caprivi Strip to punch holes to bring water to dry places, including, ironically, settlements of Bushman families relocated and abandoned there a decade after independence. Prinsloo fired up his massive flatbed and leaned out the window to wave a sleeveless muscled arm at me, "Follow us."

* * *

America's frontier was shaped by legendary pre-industrial figures set against the advancing mechanized economy: cowboy Pecos Bill, river bargeman Mike Fink, lumberjack Paul Bunyan and my favorite, John Henry, 'born with a hammer in his hand,' whose willpower and skill raced a steam-engine to hand-drill a tunnel through a mountain so railroads could follow in his path. Their time is long gone. But perhaps arid Africa may look back on 2003 as a transition point in its own frontier, a twilight era when a Bushman could still race an internationally financed, $100,000, diesel-powered Schramm drilling rig to seduce and produce a watery future from this desert's reluctant womb.

Stage 2 — Courtship

ZUTSWA, Botswana — Tebere was attracted to water but as a suitor his approach seemed rusty. He hadn't sought out and used this particular sip-well since the late 1980s. His hand-signal directions to me, driving, switched from confidence to hesitation, then back to certainty as we bumped and lurched merrily along. To confuse matters he was getting conflicting clicks and cackles from no fewer than five back-seat drivers, his relatives who had rarely been in a vehicle before. I glanced at his eyes as he scoured the landscape ahead then pointed his arm like a compass needle — Left! Right! Veer here, no HERE! Swerving madly I reminded myself that the shortest distance between two places might *on foot* be a straight line over termite mounds; but not on wheels. Tebere was not the one who would have been stranded if the suspension snapped.

Climax Pump: *This brand of windmill has become an enduring symbol of arid land water development*

I first read about sip-wells in Lawrence van der Post's romantic account of his attempt to find "some last pure remnant" of his noble "apricot skinned" savage[2]. The sip-well is the oldest form of pumped groundwater use in Africa, perhaps in the world. It can't be dug just anywhere. Falling rain usually seeps out of reach straight down through a half-mile of Kalahari sand until it hits the rock basement. But over time, in a few random places, rain picked up, bonded and then shaped clay into a thin, bowl-like membrane only a few meters down. That membrane then captured rainwater and kept it protected underground; water may slightly rise even upward in capillary action within striking distance of a man who knows where to dig.

Emphasis on: *where*. Formed over centuries, crusted over by sand, sip-wells were invisible from the sky, and impossible to find on the ground without the shared, inherited memory that links technology to place.

Tebere did not read two-dimensional books. He read the 3-D book of porcupine dens, bushes, trees, depres-

Continued on page 6

[2] In *Lost World of the Kalahari* Britain's authority on Africa bumbles all over then-Bechuanaland without luck until one of his sidekicks humbly suggests an area he knew where Bushmen sucked water from sand.

A Borehole Bank Is Born

Namibia Leads World at Forcing Water Genie Back in the Bottle[1]

WINDHOEK, Namibia – Once again this dehydrated capital has become a city under siege. Its relentless and increasingly hostile[2] enemy, the sun, already has drained two of its three critical dams and without heavy rain it will finish the third within a year, pitting man vs. sun in an interplanetary 'star' war.

Guess who's losing. Casualties began in 1953, when the booming industrial heartland supplemented its slow-yielding borehole 'wellfield' with new surface storage – the Omatako, Swakoppoort and Von Bach Dams. At the time it seemed logical; in hindsight, lunacy.

"In these hot arid places of Africa, building a dam is like offering a sacrifice to the gods (namely Apollo)," said groundwater hydrologist Christine Colvin. "All those open canals and exposed reservoirs were like putting giant cast-iron pans out in the desert and saying, come and get it."

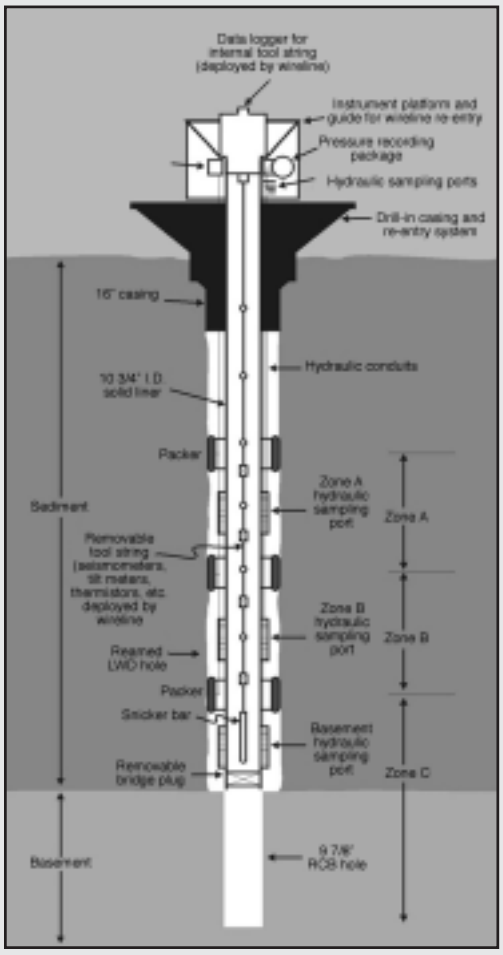
Get it Apollo did. The three dams supply 15 million cubic meters of water each year (Mm3/yr) to cities; they supply twice that to the sun god.

Helpless, as those lukewarm offerings vanish before its eyes, Windhoek tries to respond rationally without triggering panic, exodus or recession. A decade ago the city unrolled an aggressive 'demand-management' conservation program. Last year it commissioned a cutting-edge wastewater-reclamation plant. It irrigated parks, sports fields and cemeteries with dual-pipe gray-water. It raised water prices on heavy consumers and instituted rationing. Such brave moves saved a few million cubic meters but failed to appease the gods. Namibia's exponential growth has forced its government to fight a rear-guard defense, clutching desperately at any new water within reach.

Retreat held geopolitical risks. The last acute drought in 1997 drove Namibia to plan an extension of its Eastern National Water Carrier north, to Rundu, to grab a thick slice of the closest perennial river. That river happened to be the Okavango, the nearest thing Africa has to an environmental sacred cow, and one that fuels Botswana's strategically vital and fast-growing $270 million Okavanga Delta-based tourist economy, worth 12 percent of its GDP. Botswana wasn't about to sacrifice its 'life-blood' without threatening 'real blood,' and tensions escalated between the two nations until, one month before the final dam dried up, clouds burst. *Deus-ex-machina*. Divine mercy was short lived, however. Drought is again the norm, and Namibia faces a two-front war: one enemy east, one hovering above it.

But anxious hydrologists here literally have just begun to break new ground, liberating a revolutionary ally to help turn the cosmic tide against that star closest to Earth (and thus ease tensions with Botswana). If implemented, the strategy won't just relieve the city. It may negate pressure for the costly building of new dams and diversions throughout southern Africa and, indeed, throughout the arid world.

It's called 'artificial recharge.' Just as Bushmen buried water-filled ostrich eggs as a future reserve [see page 19], artificial recharge involves burying water down through borehole pipes into the fissures and pores beneath Windhoek's houses and offices. Ripeness is all: in dry seasons Namibia withdraws more groundwater from its sunproof aquifer; in wet seasons it pumps newly stored (or recycled) surface water back into those dry cracks' air pockets that the previous withdrawal left behind. Those seasons may stretch months or years, or even a decade apart. But the more water Namibia withdraws from its aquifers, the more room there would be later to refill or 'recharge' them, allowing water managers far more flexibility, security and freedom from the whims of sacrifice-demanding gods.

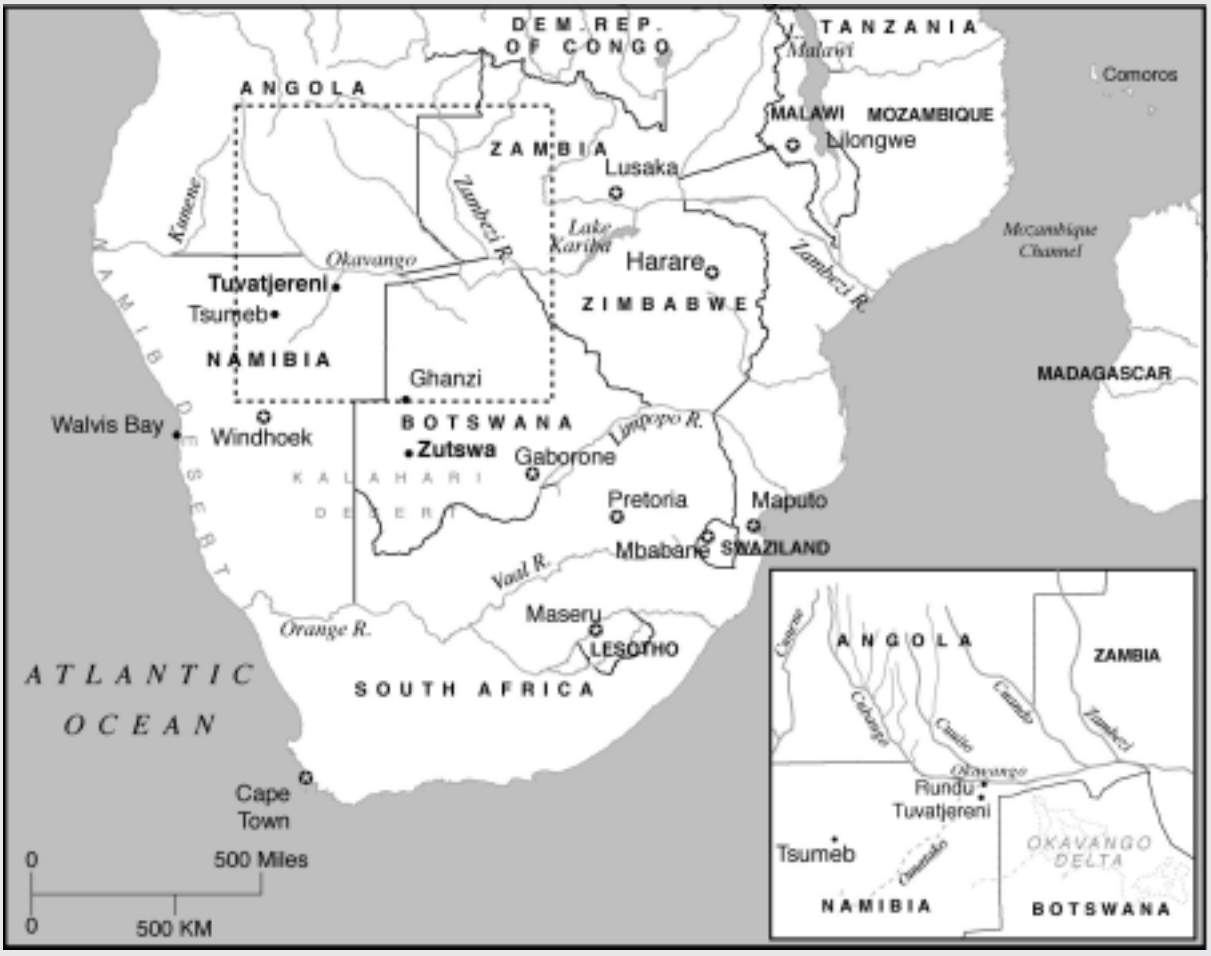


How much more? And at what cost to its people? More than tapping the Okavango?

Let's find out with some back-of-envelope math. The city had 'mined' more water from its aquifer than clouds alone could replenish naturally (a static safe yield of 1.73 Mm3/yr). After a century of groundwater 'over-withdrawals' the city springs dried up decades ago and left one hell of a negative 'bank account' to replenish. But why wait for raindrops to percolate down slowly when you can force dam water down by force at exponential rates? Why indeed? And what really makes water wonks here ecstatic is that their subterranean vault appears far deeper than imagined, allowing it to suck up and slosh back more than 100 Mm3/yr. That's

[1] Passive recharge of aquifers is widespread and centuries old. Active artificial recharge has been pioneered in California, but on simple 'primary' aquifers beneath floodplains. Namibia is the world's first to attempt this in a 'secondary' aquifer far from rivers, concealed in a complex, fractured underground landscape.

[2] I say 'increasingly' because of climate change. No one disputes that temperatures are increasing. The overall implication of this heat on rainfall patterns varies globally, but a scientific consensus is that, based on the recent past, it will lead to extremes: drier dry periods, then wetter wets.

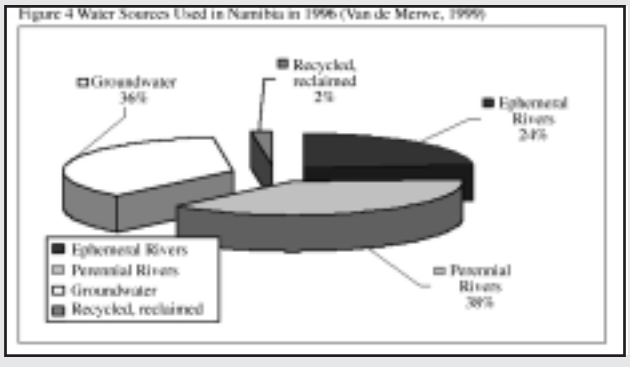


seven times what the city consumes, or five times what the sun god *evaporates* from dams each year. Imagine if the bank extended your credit card 'limit' seven fold. Interest free.

It will last as long as the city withdraws (depleting the aquifer further) and later replenishes (emptying more of dams back into it sooner) wisely. According to groundwater consultant (and former city water manager) Ben van der Merwe, "every 1 Mm3/yr of water artificially forced underground spares 0.4 Mm3 from evaporation. So if Windhoek injected 5 Mm3/yr into its aquifers, it would have an extra 2 Mm3/yr for use that would have been lost to evaporation had it remained in one of its dams."

In short, through this anti-evaporation recharge process the sacrificial gross loss of 30 Mm3/yr, if recharged, could be transformed into a 12 Mm3/yr net *gain*.

This does not mean that all water-sacrifices (a.k.a. dams) become obsolete. It just means we must 'think outside the box' and pump them dry into aquifers before the sun can pump them into air. Aquifers need surface storage to accelerate recharge if and when rain falls. More colorfully: "Once you've grabbed the slippery beast you've got to get it underground as fast as possible before it can escape," says Dr. Alan Simmonds, groundwater expert and manager of InterConsult Namibia. "But you can't capture it without a dam. Dams are still the best way man has come up with of doing just that."



Perhaps existing dams, but not new ones. At US$10 million a year, the proposed three-phase artificial recharge ain't cheap (by African standards). But the closest equivalent in security, tapping a finite source at Tsumeb, would cost US$50 million. Extending a pipeline to a dam at the Okavango River comes to US$100 million (not counting potential troop mobilization or international lawyers' fees).

Is there a drawback to forcing water underground? Yes: *on the surface*. Remote dams and pipelines let people in cities live where and how they please. But as this city now refuels, flushes, chemically scrubs, pesticide sprays, garden fertilizes, and transports hazardous materials directly over its future drinking supply, groundwater contamination has now become a high risk. Unlike a dam, aquifers once polluted are impossible to 'flush' out. So the city has begun taking tentative steps to 're-zone' and restrict developments in vulnerable landscapes above the aquifer.

One potential complication: as Windhoek's long-deceased springs spring back to life people living and working in buildings constructed on dry land may soon wake up astride ancient wetlands. But in a city under solar siege, surrounded by semi-desert, it's hard to complain about sitting on top of an oasis.

sions, dried plants, bare spaces, and termite-mound shadows thrown by a shifting sun. He read them with a photographic memory, as if they were road signs and distance markers. As if survival depended on it.

After a half-hour's drive he felt we were close. He recalled that large mopane tree, next to the acacia. Others weren't sure. Ten minutes passed with nothing but the sound of the engine. The warm cab smelled of sweat and marijuana and donkey cheeks. Then the vehicle erupted with clapping as Tebere pointed, much as Brigham Young pointed at future Mormon HQ and with a similar remark. "Yes, yes," he said, jumping out before I could brake. "This is the place."

TUVATJERENI, Namibia — For 70 winding miles along the Omataka Omuramba (local word for "seasonal river") I ate dust churned up by the two loaded trucks I followed. When we turned into thick sand near the drilling site, Brickhill's big flatbed — strapped down with pipes, sheet metal and casing material — quickly overheated, and we stopped to throw precious water against the radiator.

Prinsloo and Brickhill didn't have to read bushes and depressions to find their paramour. They only had to read exact Global Positioning Satellite (GPS) coordinates—in this case: Latitude (S) 18.31990; Longitude (E) 19.91498. A pistol-packing geologist, Annelise Wierenga, had established those numbers six months earlier, and she, in turn, relied on technical surveys, sampling, database and her long experience in the area.

Ancient Flint to Free Flames: *Thaleta, by the fire ignited by a flint spark to dry grass, just before seeking the sip-well*

By crossing personal knowledge with high-tech equipment — including expensive high-resolution aeromagnetic surveys, geophysical charts, and remote sensing data — geologists like her can detect potential 'water-bearing structures' or aquifers. Beneath us here, she told me, roughly 70 million years ago, the entire area used to be marshland from paleo-channels, or ancient meandering river flows. Now, packed beneath layers of windblown sand, those pockets of water sat waiting. "You go deep enough," she assured us, "you'll find them."

The truck cooled enough to drive the last ten miles to the site. Other men were already there, setting up camp, home for the next few weeks. We backed into place and cut the engines. A wind blew a Russet Bushwillow, sprinkling its leaves like confetti onto the heavy equipment.

"When do you start?" I asked Brickhill.

"Depends on how quickly we can get water to the site."

"Water? You need water before you can drill for water?"

This was apparently like asking whether you need eggs before you can make omelets, but Brickhill indulged my ignorance. "Hell, yeah. About a hundred thousand liters of it. You'll see why."

Stage 3 — Prenuptial Rituals

ZUTSWA, Botswana —Tebere and his clan did not need water to help them dig. What they did need was divine assistance, from God or gods or their ancestors or some melding of all the above, to guide their tools to the wet target at this particular sip-well.

By now I could barely make out the slight oval depression in the desert's surface that hinted at the mysterious secrets that could hide below in the sand. On the outskirts of this oval imprint Tebere began to lay out the crude digging tools in a special order: scoops, sticks, spoons, tubes, grasses, strings. And my folding shovel.

They gathered a special herb that, as they explained through my equally fascinated translator, Billy Ocean, was supposed to bring aid to the digging, and took turns smoking it. Then they began to dance. They danced around in a kind of wild figure-eight pattern, clapping all the while, brushing against each other, chanting a song or singing a chant. Now and then one would cough, a tubercular sound, but they did not stop dancing.

Finally Tebere broke off and picked up his digging tools. The others continued chant-singing, at a slightly higher pitch. There was excitement in the air. Anticipation. It was not a rain dance to bring water down from the clouds, but rather a sip-well dance to bring water up from the ground, within striking distance.

TUVATJERENI, Namibia — Tough technicians don't dance. But as the rig's crew did their own pre-drill ritu-

Modern Flint to Harnessed Fire: *This time the sparks fly from the focused hot flame, as a Prinsloo drilling crew welds a casing joint.*

als, songbirds arrived with festive music. A fork-tailed drongo was first to show up, followed by sandgrouse, then waxbills and several fire-finch. On the ground scorpions and solifuges inched closer, circling, drawn by the firelight in the evening and the smell of water during the day. Water does have a powerful scent, and every borehole becomes a permanent life magnet, attracting everything from insects, to antelope, to elephants. "I saw one cup his trunk over a hole and suck up water from twenty meters deep," said Prinsloo. "You'd need one hellova pump for that force."

Yet in this prep stage, the scent of water came not from the ground. Prinsloo's crew hauled it in by tanker truck, after filling up at an existing distant borehole, and then emptied its load into tarpaulin-lined ditches and ponds dug out of the sand. These interconnected pools mixed with biodegradable chemicals, then circulated through the drill end, as "CAP-21," churning at the contact point where the drill hits the ground. The drilling-fluid mixture, known simply as 'mud,' has become the most powerful drilling tool available to man. First used in the 1950s, it revolutionized borehole drilling by improving technique at all stages simultaneously.

In 'hole making,' mud cools the bit, clears it and the bottom of 'cuttings,' transfers energy to lubricate the rods, pipes and bolts, inhibits corrosion and makes the drill more buoyant. In 'hole clearing' the fluid pushes ground 'cuttings' from the hole up to the surface, keeping them suspended. In 'hole stabilizing' it controls down-hole pressure and temperature, and keeps the walls from collapsing. And in 'hole measuring' it communicates up, quickly and accurately, what is happening beneath the surface through changes in color, smell, flow, consistency and chip content. In short, 'mud' did for drilling what oil does for pistons, gel does for shaving and cement does for building.

Brickhill mixed CAP-21 into tiny reservoirs. "The key is to get it thick enough to lift cuttings but not so thick that it slows drilling," he said. He dug out a simple tool

Desert Jacuzzi: *Brickhill, left, and John prepare the drilling fluid, catalyzing a hauled-in 'man-made river' into a powerful tool technically known as 'mud'*

called a Marsh funnel, which measures viscosity by the rate a liter of mud pours out. For Kalahari sand, 36-38 seconds was ideal. I checked the stopwatch. Thirty-nine. "Add a bit more water," said Brickhill.

The overall impression was that of a ship departing a harbor. After hoisting the 'mast' from horizontal to vertical, one man tightened the 'stabilizers' while another threaded the 'guy wires.' The loading crane swiveled over to the 'hold' of a supply truck. John climbed the 'crow's nest' shouting down progress to Brickhill who manned the control panel, monitoring the dials, pressure gages, and torque like a captain barking orders. As the mud began to pump several men swabbed the drilling 'deck.'

The men hailed from eight different countries, spoke eleven different languages. Upon severing contact with town, each driller had to be welder, driver, mechanic, firefighter, barber, bartender, cook, plumber, navigator, janitor, radio operator, electrician, musician and amateur linguist. In the groggy morning the whole operation felt like a whaler floating over a sea of sand waves, the sun's glare off the horizon, watching all signs and feeling all vibrations beneath the surface, searching for likely places where a plume of spray may rise, getting ready to shout 'Thar she bloooows!' and prepare the harpoon.

Reality check. As dusk descended the heavy 'harpoon' transformed back into a tri-cone rotary-drilling roller bit with tungsten-carbide buttons. They pivoted it onto the stub, screwed the stub into the drill pipe, spun the pipe into the pulling and brake device, and turned that device into the collar. When the power swivel cranked tight at the top, the twenty-meter, one-ton shaft was hoisted, poised for its first thrust into the Kalahari.

Stage 4 —Consummation

ZUTSWA, Botswana — Soft sand had begun to fly, scooped out with a bowl, thrust away in all directions,

A First Scoop: *As the eldest male, Tebere digs the initial hole, watching for where the sand is dampest*

Avast Up Thar Matey: *A Prinsloo drilling-crew member leans out of the crow's nest, uncouples the baling clamp and prepares to screw in a drill-pipe segment.*

caught by the wind. I had to duck and dodge to avoid getting a face full, and kept circling the hole opposite Tebere's scrape trajectory. By custom the eldest man in the family had to start, but his brother, then wife and sisters, and nephew soon relieved him. As outsider, I held back. Each individual would take over digging while the other filled the place in the dance. The deeper the digging, the heavier and denser the sand layers. Progress slowed but the dance carried on. I could not distinguish work from ritual.

It was quite possible that Bushmen developed sip-wells the same way their (and our) ancestors, hundreds of thousands of years ago, developed a taste for meat: by first following, then scavenging, then imitating the methods of Africa's wild beasts. It had been documented how Bushmen chased lion off fresh kill, and vultures off days-old carcass as they moved out into arid zones, benefiting from protein. Could they not likewise, over thousands of years, have learned to chase elephant off its trunk-sucking 'gulp-well' while then learning, by imitation, to sip the desert in a similar fashion? No one knows for certain. But the erosion of this method in the past century has correlated with the arrival and growth of a not-so-wild animal to the arid landscape.

"Sip-well technology has been lost over much of the Central Kalahari," said Paul Sheller, who in the 1970s had

Dancing Into The Ground: *Three women — Maselale, Thaleta and Matate — pause from their dance to deepen and widen the pit within the sip-well as they near the contact point.*

been appointed Bushman Development Officer[3] "because of the rapid spread of all those deep boreholes drilled to pump water for cattle farms on the desert's outskirts. Boreholes did, in fact, lower the water table. Not much, mind you, but just a few inches was all that was necessary."

In that sense competition operated on several levels: Tebere vs. Prinsloo in this story; Tebere vs. thousands of neighboring boreholes surrounding the area he lived in and roamed; Prinsloo vs. other drillers in Namibia; and all Namibia drillers vs. Botswana and South Africa. Deeper and deeper they drilled, chasing the water table down even as it receded before them.

After a few hours the clan had dug three meters below the ground surface, carving out an area just wide enough to lie in, face down. The sand felt damp at the bottom. They picked up the long sharp sticks, and spoons, and gouged a narrow hole, quickening the pace.

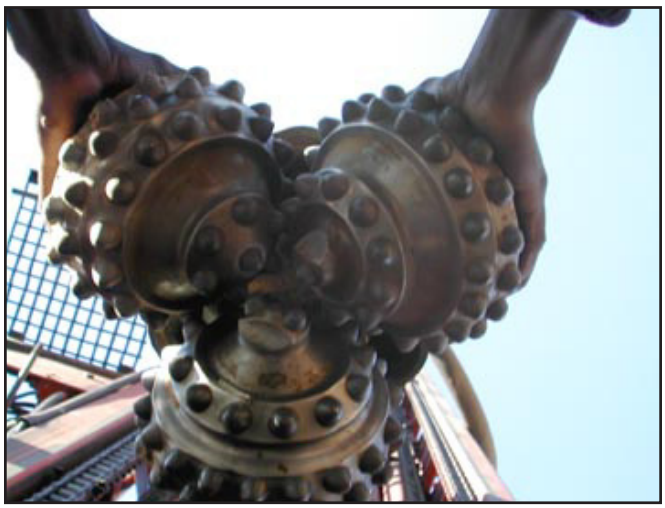
TUVATJERENI, Namibia — It took Prinsloo Drilling 37 seconds to penetrate the same distance through the sand that the D'ana clan covered in an hour.

Every meter the drill bore down churned up sand cuttings in the mud; every meter the crew scooped up a shovelful and dumped it off to the side. Cuttings varied hour by hour as the drilling fluid lifted up: fine Aeolian wind-blown sand, peat, thick alluvial sediment, calcrete, clay, unconsolidated gravel, sandstone, limestone, mudstone, shale, dolomite, karoo, quartzite, gneiss, perhaps even marble or diamond-bearing kimberlitic. When the shovelsful dried, a spoonful of each went in an ice-cube tray slot, then all the trays would be sent back to Windhoek for logging. With this data the government could, in the long term, compare all borehole samples for a precise cross-section of the country's geology.

But there were immediate short-term benefits. "It shows me what's at each layer," said Brickhill. "Is the sample too fine? Good. I like that. But calcrete and sandstone gets silified like glass silicone and it's hard on the drilling head. Grinds down the tricone's (drill bit's) buttons. Wears down a driller's pride. That's when people start swearing and shouting, because it slows progress."

What slowed progress and led to swearing, though, was the hauled-in water supply. The front-axle differential on the water tanker gave out in the sand; drilling work halted for nearly a week until it could be repaired and bring new loads to make the essential mud. Then once again, the drill plunged deeper; men slapped a second pipe on top, winched over by the crane. Eleven meters soon became twenty-three. Past the expected water-level depth.

Thirty meters. Thirty-two. At this point a hole drilled nearby had found moisture, just not enough to use. Thirty-five. Skills and attention amplified with complexity and depth. Each new drill segment added one ton or 600 kilograms of weight. Beyond the first ten meters, Brickhill used the rig not to press the drill down but hold it back, letting the weight of the shaft torque the bit



Boring Down, Looking Up: *View of Tri-cone Bit from the desert's perspective*

[3] A job-title oxymoron, Sheller said. "You can't develop Bushman in the western sense we know, because that form of development means organizing and mobilizing resources to you, not mobilizing yourself and organizations around resources, like water."

deeper. There was violence at certain points, slight resistance at breaking through invisible consolidated layers, but the vibrations and mud consistency helped Brickhill 'feel' and sense the difference at such depths, "telling me what's what down there."

It told him, meter after meter, that the water was much lower than anyone had expected. Seventy meters. Eighty. This level had been the pre-set 'maximum depth,' but as long as the water level eluded them, the rig crew kept going down. Ninety. One Hundred.

Falling water tables may be affecting Prinsloo as much as Tebere as they chase the bottom line deeper. That sinking away may not be simply a local fluke, or national challenge; it is a global issue driven by over-pumping, a phenomenon of the last few decades. Water tables are dropping five feet a year under the North China Plain; two feet a year under India's Punjab; four feet a year in the Ogallala Aquifer which stretches beneath South Dakota to central Texas. These places make up a chunk of the globe's breadbasket, and they are running dry. Indeed, eight percent of the food that feeds the world's six billion people is grown with water that's not replenishing. There's one benefit of over-pumping groundwater, a strong one: it delays the eventual reckoning of an ever-higher global grain price.

Despite a few expressed concerns of environmental groups and even officials, there but few installed meters on boreholes. That means Namibia has not yet managed to monitor or measure — much less regulate — how much water its 7,000 government, 13,000 communal or 30,000 commercial boreholes are pumping each year. It also means many get drilled in the wrong place, for the wrong reasons at the wrong time.

Looking Down, Churning Up: *bringing the bit back up through the hole is a delicate operation.*

One Ten. One Twenty. Only at 124 meters does the mud change color and consistency. "Finally," said Prinsloo. Drilling stops. They've hit it.

Stage 5 — Conception

ZUTSWA, Botswana — As the sand felt damper, Tebere slowed, growing cautious. If he dug too shallow, not enough water would form to sip. If he dug too deep he might puncture the clay membrane, leaking water out of sipping reach.

I had imagined water like oil: once hit, the hard work was over. Liquid gushed eagerly to the surface like uncorked champagne or a punctured artery. That could happen with water compressed beneath or between cracks in a 'fractured, confined' aquifer, referred to as 'artesian.' Not here. In the Kalahari's 'unconfined, unconsolidated, porous' aquifers, water lazed comfortably between grains of sands reluctant to stir unless forced to.

For both clans the end of basic drilling meant the intricate, difficult part had only begun. Up to this point they worked with gravity;

***New Rubber, Old Technique**: Thaleta fastens the traditional grass-filter plug to the modern red tube*

Tough Guys Do Smile: *Rig roughnecks manhandle a half-ton drill segment into place.*

now both battled against it. We may assume gravity ends at ground level because that's what stops solids, like us. But gravity continues to pull liquids deeper, through pores and grains and cracks until it hits an impermeable layer. Even then, unless the layer is flat and sealed, gravity keeps pulling: a cubic meter of water weighs roughly a ton.

Against this pull, men like Tebere or Prinsloo must develop x-ray vision to see down through three dimensions and think like water, asking 'where would I go if I were it?'

Thaleta tied a bundle of dry grassy reeds around the end of a tube and handed it to Tebere. Traditionally, the tube had been a native plants that grew in parts of the Kalahari. But Bushman adapted technology, just like anyone else. A 'real' Bushmen hunter cuts poison arrowheads from steel fences and carries quivers made from PVC pipe. Likewise a 'real' sip-well developer uses a red rubber hose as his suction tube. Once wrapped by that absorbent (and traditional) grass filter at the bottom, he plugged it into the hole.

TUVATJERENI, Namibia — Withdrawing the drill back up the hole was, in reverse, like rappelling a rock climber back down a cliff face: it's the most dangerous, vulnerable stage where costly mistakes are usually made. Men may let their guard down, or relax, or forget several dozen tons of steel still dangled in a hole that could collapse.

To prevent that, Prinsloo's team inserted the inner lining, or casing. Like a recipe, these ingredients had been laid out in segments, and then screwed together in preparation for this moment. The recipe was fit to the geo-hydrologist's specifications: One 12 meter steel casing standpipe; 48 meters of plain UPVC 150 millimeter diameter; 32 meters perforated uPVC; 13 centralizers (like knee braces) to stabilize joints where they are screwed together; 5.2 cubic meters gravel pack; one plug cap to be welded on at the end. They had to add more as they drilled past the expected 80-meter max depth. The gravel pack kept the casing vertical, and filtered out the sand; perforated segments let in water while filtering out gravel.

"Casings go in after drilling is complete," said Brickhill. "It's our most vulnerable time. If it collapses, we can always re-drill but if casings are already in there, we won't get them out."

Earlier, as the rig sank its harpoon to the hilt, I noticed the crew slide brace plates around the hole and into the pipe to rest the drill chain while they screwed on a new segment at the top. The obvious danger occurred to me.

"Ever had something drop down the hole?" I asked.

"Not yet by my team, touch wood," said Brickhill.

"What happens if you do?"

"Have to recover it by various methods. These parts are expensive. Reach back down."

"What's that process called?"

Brickhill smiled. He'd heard my whale-ship analogy. "Actually, it's called a fishing expedition."

I jinxed him by asking. For a week later — after they fixed the water-truck differential, completed the drilling,

Lung Powered Pump: *Tebere starts to suck up the vital, pure, sweet life-sustaining liquid*

and installed some of the casing, and through no fault of the crew's — part of the hole collapsed, trapping some casing with it. After days of fishing, and cursing, and coming at it from several angles, Prinsloo and Brickhill finally recovered the piece, completed the casing, withdrew the drill, and capped the hole. Ready to pump.

Stage 6 — Childbirth

ZUTSWA, Botswana — At this point Tebere and his clan moved quickly. They took turns lying flat, face down, gripping the red hose to their lips, and sucking. Rather than take a few long slow draughts, they inhaled in swift, short, sudden bursts.

It was while watching this motion that I developed the loose metaphor around which this dispatch has been structured. The sucking could only be described as intimate and, well, erotic, engendered by need for sweet, cool, clean water. It was a primal connection of humans to the native landscape that sustained them. But who was the parent and who the child? The focused intensity of the effort evoked an adult at a lover's lap or an infant suckling at a mother's breast.

In either case, the pump abstracting groundwater to the surface, in this instance, was no stronger than a pair of human lungs. Given the depth, and weight, this still took considerable energy. But little by little the water rose to the top.

Tebere was the first to drink, then his brother X'uno, then the women. Pure and clear, it had come in contact with nothing but sand. Down in the darkness, away from sunlight, no dangerous microbial life could grow. Tebere smiled at me, and smacked his lips. "Ahhh."

TUVATJERENI, Namibia — On average, only 65 percent of boreholes drilled in Namibia are successful. The rest are stillborn.

That means more than a third don't yield enough water to make a pump worthwhile. Or it means they're too salty, too filled with dissolved solids, too difficult to operate, too clogged to flow, or too expensive to pump and maintain. So those get abandoned. In fact, the first Northern Livestock Development Programme borehole for this village — #40410, drilled a stone's throw north of this one — wasn't deep enough. It yielded only 200 liters per hour at 52 meters deep. That would be plenty enough water for a clan of Bushmen like Tebere's to survive on, but Bushmen like him weren't paying the bill.

The United Nations was. And to boost livestock in loyal villages, it wanted five times that amount. "Drill deeper," came the order. "You'll find water." Prinsloo had, and did.

The drill bill wasn't cheap. Clients paid rigs like Prinsloo's N$1,000 (about US$150) per meter just to puncture through Kalahari crusts. That's before adding diesel, parts, geologist contractor, casing and value-added tax. As that tungsten carbide drill bit bore deeper the tab got higher. The sum for three boreholes — whether they came up dry, wet, or both — often came to roughly US$120,000, or roughly US$1,000 per user.

And then there was the all-critical pump. At a ton per cubic meter, no lungs, not even an elephant's, could suck up water from such dark depths. A hand pump could not go deeper than 70 meters, max, and even then could haul only 1,000 liters per hour, or 1 percent of the hole's capacity. This one, 124 meters deep, would require a wind, solar, or diesel pump. At US$14,000 each, diesel pumps were the cheapest to install and most powerful suction force. So long as the government was in charge of water and was picking up the check for fuel, this was the top pump demanded. It let people pump, or more likely *over-pump*, to their heart's content.

Why Dry? *Brickhill uses a Piezometer test to compare moisture level in a nearby borehole that did not yield enough water at its depth.*

No longer. Now, by abstract law and economic force, the government was 'devolving' ownership down to local communities. It could not afford to subsidize groundwater past a certain point, even in rural areas.

Wind vs. Solar: *Which pump's power to choose depends on depth, use and ability to pay.*

Besides, doing so often led to neglect and abuse. So it was turning over responsibility for maintenance, use and operation to the people who used the water. Not surprisingly, the locals were loath to pay for diesel out of their own pockets, and so were scrambling to make the government retrofit boreholes with wind pumps (US$17,000) or ideally, solar pumps (US$24,000), before handing over these water points. They trusted sun more than wind.

I'd been carefully watching that 'devolution' to some form of Water Point Committees (WPCs) each time it cropped up in Africa (JGW-1, 5, 12, 15, 17, 18). It always seemed the 'right' thing to do in terms of attaching a value, and thus conservation incentive, to water. Yet government hydrocrats appeared far more eager to wash their hands of the pain of official responsibility than they were to let go of the power and influence that went with it. The resulting transition proved extremely difficult, halting, confusing and sometimes inequitable when it came to boreholes in remote areas.

"Often we're caught up in politics," said Prinsloo. "It's only because someone out here is well-connected that we're drilling. Other places, you can see in the peoples' eyes how badly they need more water, but we have a contract; we have to move on.

I heard a similar echo even at the top echelons of power. Drought and pleading from certain constituencies lead to bad, impulsive and reactive decisions. "Over a decade ago I was ordered to sink hundreds of boreholes in a fragile area everyone saw would be a disaster because it would lead to overgrazing and overuse of water," said Piet Heyns, Namibia's Director of Resource Management. "Environmentalists were in my face, but I actually agreed with them; it would be terrible. But if the Statehouse orders something, you do it, or else resign. And if you resign they'll still do it without you. So I drilled."

It's not all bad news. In cases with an established order and secure land tenure, devolution of water management can lead to wise use. For example, tribal authorities, backed by indigenous knowledge of their home landscape, often could smoothly incorporate water use into their traditional power structure. In diverse, mixed areas, the wealthiest landowner sharing a borehole typically became leader; he paid the water fees of others, then extracted labor and the lion's share for himself as reciprocal dues. Water got bartered like feudal tithes.

That was at least a locally developed give-and-take system. But around post-independence resettlement areas in the Kalahari, transitions were crammed down the throats of relocated Herero and Bushman minority groups as the government washed its hands of responsibility and pulled out. In Gam — halfway between Tebere's sipwell and Prinsloo's drilling rig — government officials explained, "There was dissatisfaction amongst the people, but they have now accepted the policy because they have no choice."

Ah, democracy.

Stage 7 Nurturing

ZUTSWA, Botswana — Quenched, the D'ana clan began to relax. Singing and dancing ended. A calm fell over the group. In the course of the sip-well ritual, Tebere reinforced the integrity of his clan, and impressed the technique on a younger generation. Throughout time, sipwells enabled Bushmen to live and travel where they

wished even in remote landscapes, free of constraints, free of persecution, free from pursuit.

Tebere's family will remember the spot, and may return again and again whenever the need arises. They did not sip out more than the rain put back. Should the water tanker not come tomorrow, should the Tswana deny them access, should that Israeli de-sal plant never get fixed, well, by then there will be enough water to drink again. If not, there is another place Tebere knew of on another radius. They would just have to move there on foot, which does not involve packing much.

Before leaving the site, they gathered some empty plastic bottles. Holding these next to their mouth, they sucked up mouthfuls from the sip-well, then dribbled the water back into the bottles. These they took along with them, once again adapting new technology to an old technique. Plastic had replaced the old storage vessels, hollowed-eggshells stolen from ostrich, stuffed with impermeable grass as a plug. Bushmen had used these canteens for centuries. They carried them with them when they traveled, or hid them as mini-reservoirs where only they could find at a later time — a technique Western man has begun to imitate on a large scale [*See side story: A Borehole Bank is Born*].

Without Tebere as guide, I would be unable to lead you back to the site if you paid me. The heavy wind, sun and what little rain falls there have since eroded my tire tracks.

TUVATJERENI, Namibia — What happened after he drilled and capped a borehole was, strickly speaking, not Prinsloo's problem. He and Brickhill and their crew were simply hired to deliver water, then hand it over to the proud NOLIDEP parents — in this case the U.N. (which would list the drilling in their annual report and brochures), the Namibian government (which would send a SWAPO party official out for a handover to cement loyalty), and the local village (which did not appear or get involved even once during the entire drilling). Usually drillers did this with pride, even joy. The water they found was ample and sweet, and the nearby village was in need. But there were times they had seen just enough of the parents to discern what kind of life was in store for the newborn.

"Sometimes we secretly hope we hit salt [water]," said Prinsloo. "Or come up dry, because the guy who gets it's such an asshole. We know he's going to abuse it, suck it dry, exhaust the landscape with 10,000 cattle or make soil sterile through bad irrigation, then move on and demand a new borehole." If the client is rich or connected, he gets it.

Again and again I heard this refrain from geohydrologists and drillers. They'd excitedly describe the Wild-West atmosphere surrounding borehole siting, drilling, fishing, complications and challenges overcome: lions, meteor showers, tall tales and horror stories. They became high-tech nerds about the latest percussion wavelength resonance, GIS, imaging, whatever. They spoke of water like a worthy foe, an old flame, a stealthy chess partner. They were proud of their hard work, had something tangible to show for it, and wouldn't trade it (on most days, anyway) for a better-paying desk job, pushing papers.

***Thousand Points of Water**: In this particular corner of the Kalahari, concealed and protected by a thorny kraal, Bushmen hid their winter water in melons, rather than in buried ostrich shells. Melons as 'water points' were the oldest way of showing land tenure, but were ignored by white and black latecomers.*

Yet ask what happens after they install a pump, and they get subdued. The eyes wince. They sound like a mechanic or designer of a hand-made car just presented to a spoiled teenager. They can make recommendations, based on step-pump tests that show sustainable yield and recharge rate. They can argue that certain boreholes should not be used at all, despite their water yield. They might point out that "temporary drought-relief boreholes" have become an ecological and socioeconomic disaster when they were allowed to operate permanently. But all this advice, based on decades of experience, may be ignored right off the bat or later forgotten for short-term economic or political gain. Until the boreholes suck air, the water slowly sinks, and drillers are rehired to fix it, or rehabilitate

it, chasing it down, deeper and deeper.

"The key issue in devolution is ownership," said Brickhill. "If you don't have a sense of communal, or tribal or individual ownership of a borehole, then you can't stop others from using it, abusing it, until it runs dry. Any of these villages could sell a few of their cows in exchange for borehole rehabilitation themselves. Then they'll take good care of it, stick around, and make sure it lasts for the next generation."[4]

So who won?

Measured by time, Tebere's quest took hours; Prinsloo's weeks.

Measured by skill and resourcefulness, it was a draw. I came away from the dueling drillers with as profound a respect for Prinsloo's crew as for Tebere's. Both proved incredibly inventive; to them all materials were fungible, plastic, shaped to their needs. Brickhill even spoke of designing a borehole rig, of local parts, made for the vast harsh African landscape instead of Europe's tamer surface.

If stuck, force it: *John Sr. swings a sledge to unscrew the drill bit. It was later loosened by a blowtorch heating the joint.*

Measured by output, both practiced 'groundwater seduction' as part craft, part art. Differences between them broke along lines of technology, rather than technique, and over quantity, not quality. Tebere arguably employed the oldest method of pumping water from pockets in the ground; Prinsloo stayed on the cutting edge of the industry, literally and figuratively.

Measured by value? Well, just as with America's frontier folk heroes like John Henry, there lay at root a moral difference in the scale of operations. Prinsloo and Brickhill and Wierenga (the geohydrologist) understood water in all its hidden complexity, and had success due to power, finances, diagnostic tools and decades of experience. They could quantify water in ways Tebere never could. But after weeks, months, years and the service of strangers, they were forced to move on from place to place and surrender 'their' hard-earned water for others to own. By contrast Tebere's clan alone remained loyal to that one tiny concealed spot. It remained loyal to them. A sip-well allowed independence and mystery that the modern economy and diesel force of mobile drilling rigs could not.

Measured by the 'seduce and produce' metaphor, the difference between San sip-wells and roughneck boreholes was not between love and lust; both techniques share passion and respect for groundwater hiding in its chaste place. It is rather a difference in intimacy and commitment. The Bushmen initiate a mutually sustaining marriage with water, a lifelong fruitful relationship sundered only by death. Modern industrial drillers engage in a fleeting affair, where the predetermined end always hovers in sight, where the yield is turned over to indifferent parents, and where both parties turn away wondering *What if*. ❑

[4] Of course, by doing so their relationship with groundwater might more closely resemble the Bushman's, whom most blacks and whites viewed with pity, disdain, or contempt.

INSTITUTE OF CURRENT WORLD AFFAIRS
Fellows and their Activities

Alexander Brenner (June 2003 - 2005) • **EAST ASIA**
Alex received a B.A. in History from Yale in 1998 and has just completed a Master's degree in China Studies and International Economics at the Johns Hopkins School of Advanced International Studies. He is prepariing for his two-year ICWA fellowship in China with four months of intensive Mandarin-language study in Beijing.His fellowship will focus on the impact of a new government and a new membership in the World Trade Organization on Chinese citizens, institutions and regions both inside and far from the capital.

Andrew Rice (May 2002 - 2004) • **UGANDA**
A former staff writer for the *New York Observer* and a reporter for the *Philadelphia Inquirer* and the Washington Bureau of *Newsday*, Andrew is spending two years in east-central Africa, watching, waiting and reporting the possibility that the much-anticipated "African Renaissance" might begin with the administration of President Yoweri Museveni. Andrew won a B.A. in Government from Georgetown (minor: Theology) in 1997 after having spent a semester at Charles University in Prague, where he served as an intern for *Velvet* magazine and later traveled, experienced and wrote about the conflict in the Balkans.

Matthew Rudolph (January 2004-2006) • **INDIA**
When work toward a Cornell Ph.D. in International Relations is finished, Matthew will begin two years as a Phillips Talbot South Asia Fellow looking into the securitization and development of the Indian economy.

Matthew Z. Wheeler (October 2002-2004) • **SOUTHEAST ASIA**
A former research assistant for the Rand Corporation, Matt is spending two years looking into proposals, plans and realities of regional integration (and disintegration) along the Mekong River, from China to the sea at Vietnam. With a B.A. in liberal arts from Sarah Lawrence and an M.A. from Harvard in East Asian studies (as well as a year-long Blakemore Fellowship in Thai language studies) Matt is also examining long- and short-term conflicts in Burma, Thailand, Laos and Cambodia.

James G. Workman (January 2002 - 2004) • **SOUTHERN AFRICA**
A policy strategist on national restoration initiatives for Interior Secretary Bruce Babbitt from 1998 to 2000, Jamie is an ICWA Donors' Fellow looking at southern African nations (South Africa, Botswana, Mozambique, Zambia and, maybe, Zimbabwe) through their utilization and conservation of fresh-water supplies. A Yale graduate (History; 1990) who spent his junior year at Oxford, Jamie won a journalism fellowship at the Poynter Institute for Media Studies and wrote for the *New Republic* and *Washington Business Journal* before his years with Babbitt. Since then he has served as a Senior Advisor for the World Commission on Dams in Cape Town, South Africa.

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