The Deadly Tin Inside Your Smartphone

On May 29, in the bottom of a tin-mining pit on Bangka Island in Indonesia, a wall about 16 feet high collapsed, sending a wave of earth crashing down on a 40-year-old father of two. His name was Rosnan. The dirt crushed his legs, sent something sharp slicing through his right thigh, and buried him from the waist down. His partner, panicked but unhurt, scrambled out of the pit screaming for help. About 20 other miners rushed in to dig Rosnan out with their bare hands.

“He kept repeating, ‘Please, please help me,’ ” recalls Rosnan’s son, Dian Chandra, 20, who rode in the back of a car with his father to a nearby hospital. Rosnan lost too much blood. “I couldn’t find a pulse,” says Dr. Mario, the emergency room physician on duty. Dr. Mario declared Rosnan dead at about 3 p.m. (Like many Indonesians, including Dr. Mario, Rosnan had one name.) Back at the mine, someone stuck a withered sapling into the soft bottom of the pit near the spot where Rosnan fell—a far too frequent sight in the mines of Bangka [1], where Rosnan was the first of six to die on the job during a single week this spring. The other victims didn’t make it to the hospital. All, including a 15-year-old boy, were buried alive.

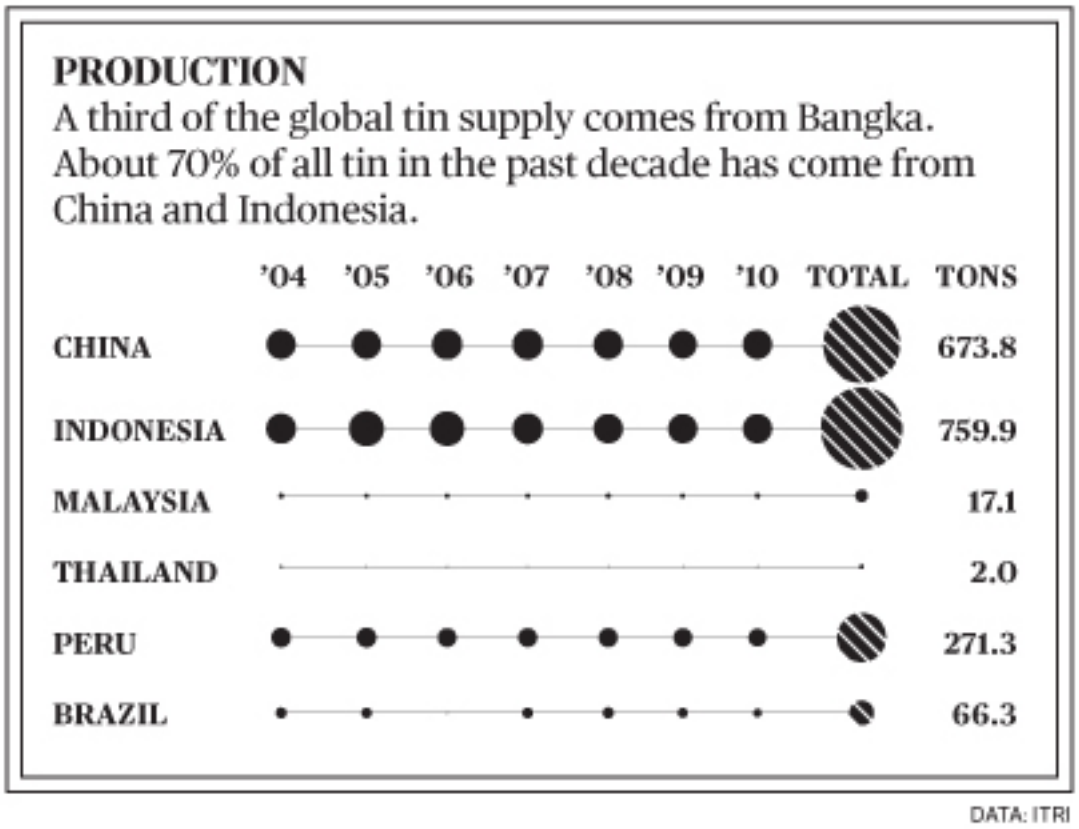
Miners on Bangka Island, near the pit where Rosnan was killed when the wall collapsed

Three days after Rosnan’s death, and following Friday prayers at the local mosque, his family and friends gathered to mourn him at his brother’s cinder-block home. They sat on the bare floor, sharing a meal of rice, noodles, and fish stew. Rosnan’s

57-year-old brother, Rani, recalls that Rosnan had few options outside the pit. “We have to live,” he says. “We need money.”

The head of the village said the area where Rosnan was working was an illegal mine, and that it would be refilled and re-seeded. Yet even as Rosnan’s family was mourning, three teenage boys, soaking in the rain, scraped for tin ore at the bottom of the same pit, right near the sapling. Two said they were 15 years old, the third 16. All were barefoot in knee-length shorts as they dug into the steep, sheer face. They were among about a dozen miners working in the immediate area. They knew about Rosnan’s death, and kept digging.

Rosnan worked among thousands of Indonesians who wield pickaxes and buckets each day on Bangka Island, extracting the tin that becomes the solder that binds components in the world’s tablet computers [2], smartphones, and other electronics. Police figures show Bangka miners died in accidents similar to Rosnan’s at an average of almost one a week last year, more than double the rate from 2010. There is good reason to believe it’s getting worse. At the end of July, five Bangka miners were killed beneath another mudslide.

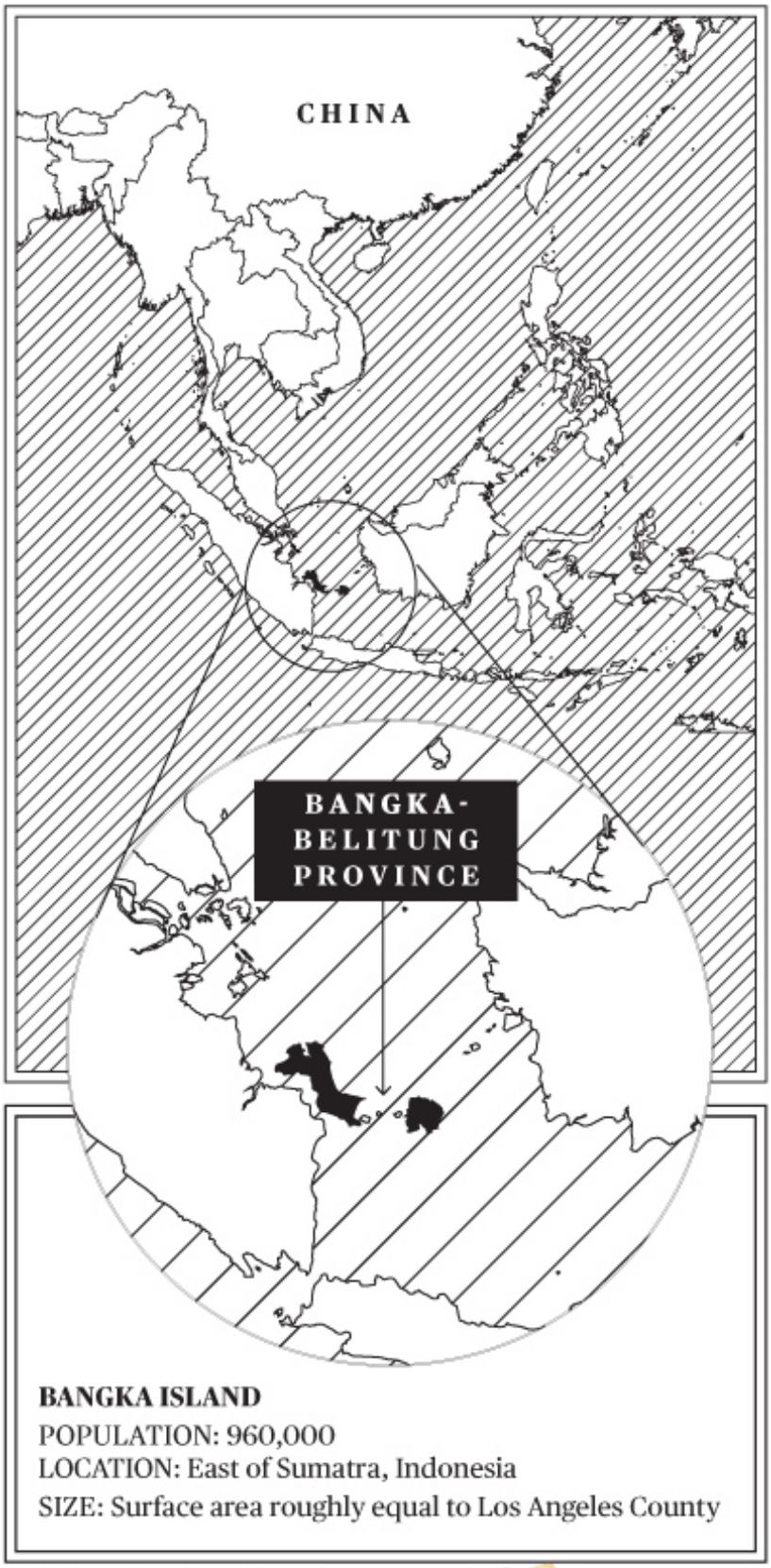


In recent years about one-third of all the tin mined in the world has come from Bangka, its sister island Belitung to the east, and the seabeds off the islands’ shores. Because almost half of all tin is turned into solder for the electronics industry, a dominant force in the global tin market today is tablets and smartphones bought by consumers in the U.S. and elsewhere.

The trail from the dangerous mines to the leading names in electronics, including Foxconn Technology Group (HNHPF [3]), the biggest manufacturer for Apple (AAPL [4]) and others, is clear. Shenmao Technology and Chernan Metal Industrial—two of the top solder makers in Asia, both suppliers to Foxconn—say they buy 100 percent of their tin from Indonesia. Shenmao estimates it's the dominant supplier of solder to China, the cradle of electronics manufacturing, and accounts for 16 percent of the global market. Chernan says other clients have included Sony (SNE [5]), Panasonic (PC [6]), Samsung Electronics, and LG Electronics. Several other solder makers declined to discuss their tin sourcing. But their product is so crucial to electronics that tin is the most common metal used by Apple suppliers, according to data Apple made public earlier this year; 179 suppliers for the company, maker of the iPad and iPhone, which are assembled by Foxconn, use tin in components for Apple. **The top of seahorse-shaped Bangka is about** one degree south of the equator, just off the eastern coast of Sumatra. It has a population of about 960,000 and has been known for tin for centuries. In 1841, when the Dutch controlled the island, an account described an island rumored to be so saturated with the metal that it was poisoning residents until "the unfortunate wretches invariably perished."

Today, swaying palms shade white beaches along its coasts, but inland, mining has wrecked the landscape. Vast patches of the island are stripped of their rubber trees, palm trees, and tropical grasses. In their place are thousands of craters punched into the tan and red sand, as if meteors had showered down from the heavens.

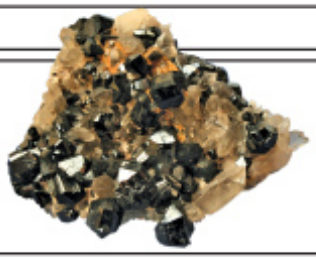
Miners hunt near Bangka's surface for veins of cassiterite, a dark mineral that is the principal tin ore, and virtually all of the work is done by hand [7]. While estimates from tin industry officials are wide-ranging, there may be anywhere from 15,000 to 50,000 miners on permitted and unpermitted sites, scrounging in the pits of Bangka and Belitung. The craters are roughly round and usually about 15 to 40 feet deep. Inside, miners work in groups of three to five, hunched over hoes and pickaxes, or crawling on their knees to scoop the walls with their hands. If they're lucky, the members of a crew find enough "tin sand" to each earn about $5 a day, sometimes a bit more. The quest for tin touches virtually everything on Bangka. Even in the province's capital, Pangkal Pinang, where mining is officially banned, renegades have dug craters near the airport's sole runway. There are pits about 800 feet behind the parking lot of the governor's office. And there are pits within sight of the island's largest hospital.



BANGKA ISLAND
POPULATION: 960,000
LOCATION: East of Sumatra, Indonesia
SIZE: Surface area roughly equal to Los Angeles County

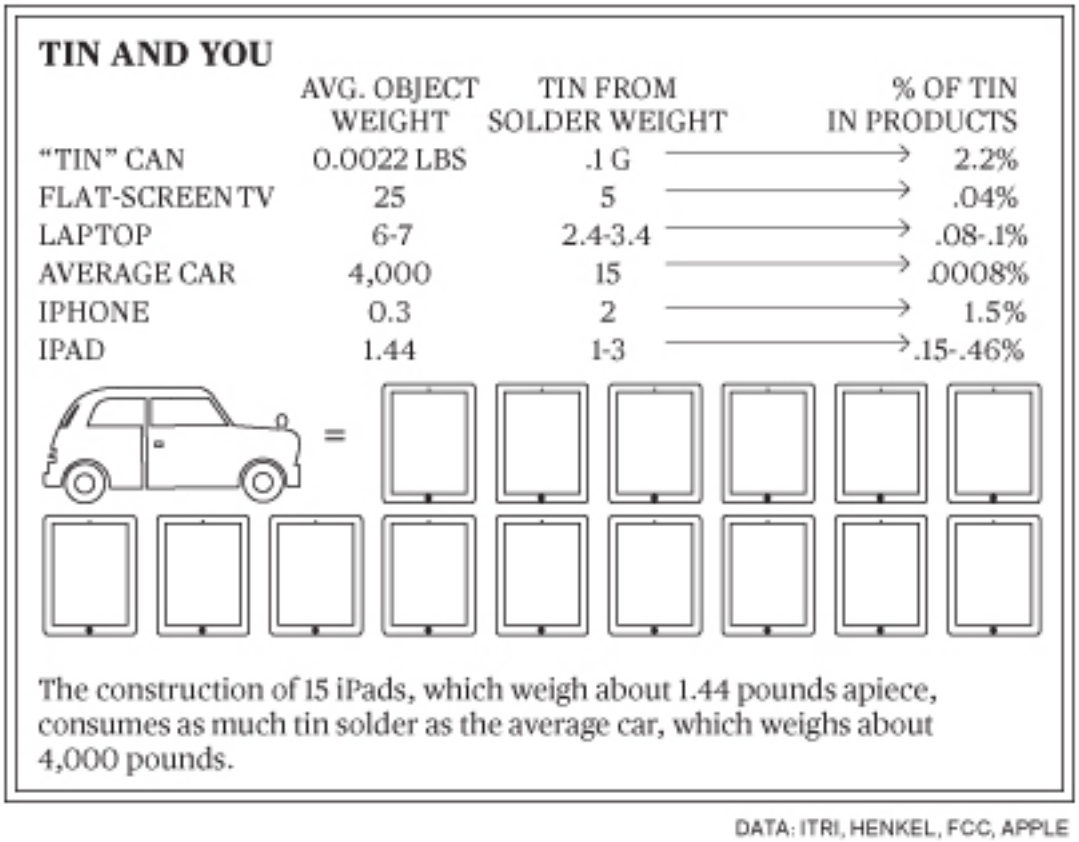
GRAPHIC BY BLOOMBERG BUSINESSWEEK

WHY BANGKA?
Bangka's soil is rich in a tin ore called cassiterite. It has been mined for centuries.



Demand is pushing the mining offshore, too. There, an armada of dredges suck ore from the seabed [8] with the government's blessing, plying waters that have supplied fishermen since boats were first carved from tree trunks. The dredges, which look like little metal factories bobbing on the surface of the sea, work side by side with thousands of floating small-scale miners, three- or four-man crews atop homemade dredges, made with poles and blue plastic barrels. Each has a diesel-powered pump to suck up the ore. They have overtaken beachside villages once dominated by fishermen or domestic tourists.

Though ubiquitous, the small-scale mines floating along the shore, and many on the island, are technically illegal. This does not seem to matter. Mined legally or illegally, from land or sea, tin ore from Bangka and its neighbor island flows each day into the global supply chain. **Tin is often associated with soup** and questionable meats, but tin cans were replaced long ago by containers made from far cheaper steel, lined with plastic or extremely thin coatings of tin, which does not corrode. Tin's real use is for solder. Electronics manufacturers use solder, which today typically contains more than 95 percent tin, to attach and connect components. The solder points are tiny but omnipresent, numbering about 7,000 in just two of the components in an iPad, according to research company IHS's (IHS [9]) iSuppli. A large flat-screen television can contain as much as 4.8 grams of solder, according to German solder maker Henkel. The iPad or a competing tablet can hold at least 20 percent of that amount, with its tin content weighing in at anywhere from 1 to 3 grams, according to Henkel and ITRI, a U.K.-based industry trade group. That means the construction of as few as five iPads, which weigh about 1.4 pounds each, consumes as much tin solder as the average car, which weighs about 4,000 pounds.



DATA: ITRI, HENKEL, FCC, APPLE

London-based solder maker Cookson Group told investors in a Feb. 27 presentation that growth for its solder was “still underpinned” by “buoyant” sales of three things: smartphones, tablets, and Internet data servers. Foxconn confirmed it uses solder made of Indonesian tin from, at a minimum, Shenmao and Chernan. But the company declined to say what share of its total might come from other solder makers who buy tin elsewhere. In an e-mailed statement, Foxconn said it follows international standards for supplier responsibility and its own internal code of conduct.

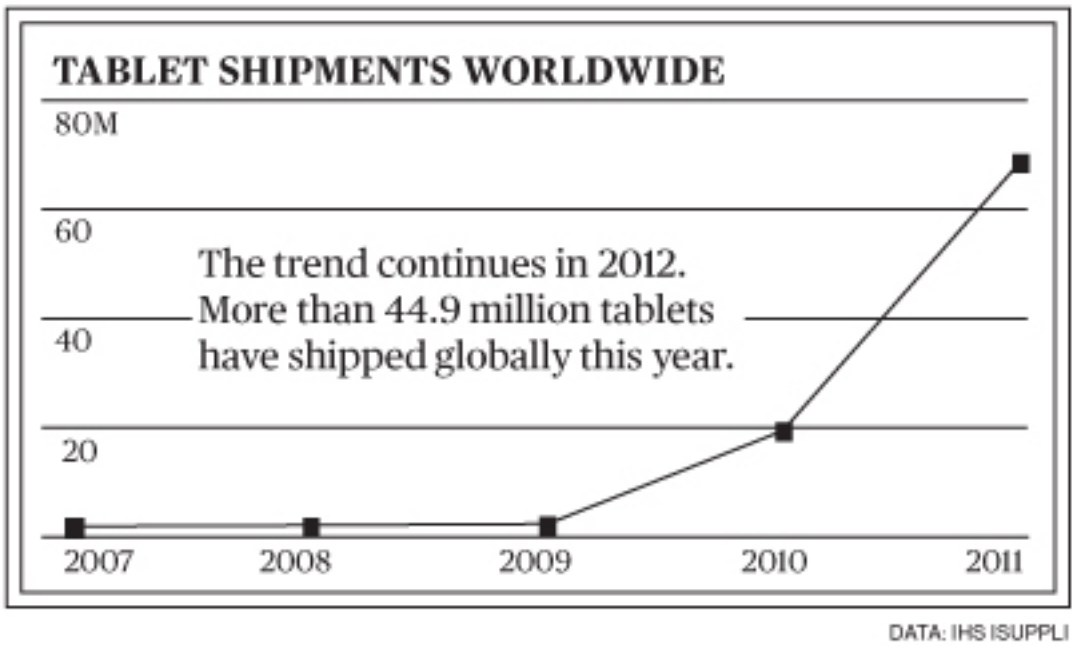
Indonesian tin is becoming more desirable for companies hoping to avoid controversy over sourcing materials in Africa. On Aug. 22, as part of the Dodd-Frank act, the Securities and Exchange Commission required U.S.-listed companies to start disclosing whether any “conflict minerals” from Africa’s war-torn Democratic Republic of Congo are in the supply chains for their products. Buying Indonesian tin is the expedient route to a “conflict-free” guarantee, solder makers say.

Prompted by concerns about Africa, Apple said in a report this year that it had traced solder used by its component makers to 58 of the world’s tin refiners, but it did not publicly identify them. Contacted for this story and told of some of the conditions on Bangka Island, Apple spokesman Steve Dowling declined to comment on the identities of any of the tin refiners in Apple’s supply chain or their locations. He did say Apple provides funding for education programs in Indonesia, but this is intended for locals who may be lured into coercive labor at Asian electronics plants.

ITRI says about 70 percent of all tin in the past decade has come, roughly equally, from two countries: Indonesia and China. About 12 percent of China's production comes from small-scale mining pits, too, according to ITRI data. As with many commodities, China does not often export tin, holding on to it for domestic manufacturers. As the world's largest tin consumer, China also must import the metal or unrefined ore from other countries. In the first half of this year, it imported 13,582 metric tons of refined tin, with more than 49 percent coming directly from Indonesia, Chinese customs data show.

Indonesia, by contrast, exports virtually all of its tin, and more than 90 percent of it comes from the Bangka-Belitung province, according to the government. This means the bulk of worldwide tin exports originates in and around Bangka, and that most phones for sale in the U.S. almost certainly have a little piece of the troubled island inside. **Six days after Rosnan died, in a village** about six miles away, Robin Simanjuntak, a local Bangka police commander, sat on a rickety wooden bench on the front porch of a one-room home. Inside, the body of 18-year-old Johidi bin Gunadi was laid out in the middle of the reception room's floor, shrouded in a gold, yellow, and black striped blanket. About a dozen family members and friends were present, most sitting cross-legged on the floor. Their heads were bowed, but their voices carried communal prayers out into the evening air as the police commander described what happened.

Only a few hours earlier, Johidi had been working with two older men in a deep tin pit along a mud road a couple of miles behind the village. The pit began to cave in, the commander says, using the Indonesian word *longsor*—"landslide." The two older miners bolted away from the cascading mud, while Johidi, apparently confused, ran toward it, the commander says. It took three hours, about 50 villagers, and two excavators to uncover Johidi's body from beneath 16 feet of dirt. When their search was finished, rescue party members mounted their motorbikes or climbed into the few vehicles parked on the edge of the mining site. Under a tropical downpour, they formed a long procession and streamed toward the village along the wet road. Up front was a black Suzuki flatbed truck carrying Johidi in the back, cradled in the arms of a villager.



Like Johidi, most of the bodies of miners killed in the pits go straight to families for burial, as is Muslim custom. Dr. Mario, the doctor who declared Rosnan dead at the government hospital, says he has seen only a few unclaimed bodies of miners brought into the hospital's morgue, where he also works. These are most likely migrants from impoverished areas of neighboring islands who come to Bangka to scratch out a living in the tin pits. Last year police in Bangka counted 44 deaths in the pits, more than double the 21 from 2010. A police spokesman says many cases may go unreported.

Some pits are unstable because they are dug straight down. Mining in a terraced pattern, with shorter, staggered walls, is far safer; it also takes more time and effort. In one of the pits adjacent to where Johidi died, the dangers were obvious. The pit was deep, and its walls were nearly vertical. Striations showed the walls were freshly cut with the bucket of an excavator—according to miners at the site, one of the same excavators used to unearth Johidi's body.

As the mining continues, it becomes more dangerous. The world's biggest exporter of refined tin, Timah (TINS [10]), a publicly traded company based on Bangka, says ore concentrations have plummeted 63 percent on the island in just the past two decades. Scarcity creates the need for deeper mines, which are more likely to cave in. "I don't know about the deposits in the land," says Johan Murod, a portly businessman who owns three tin smelting plants [11], and a dredge. "But if the price is high, we can just dig deeper."

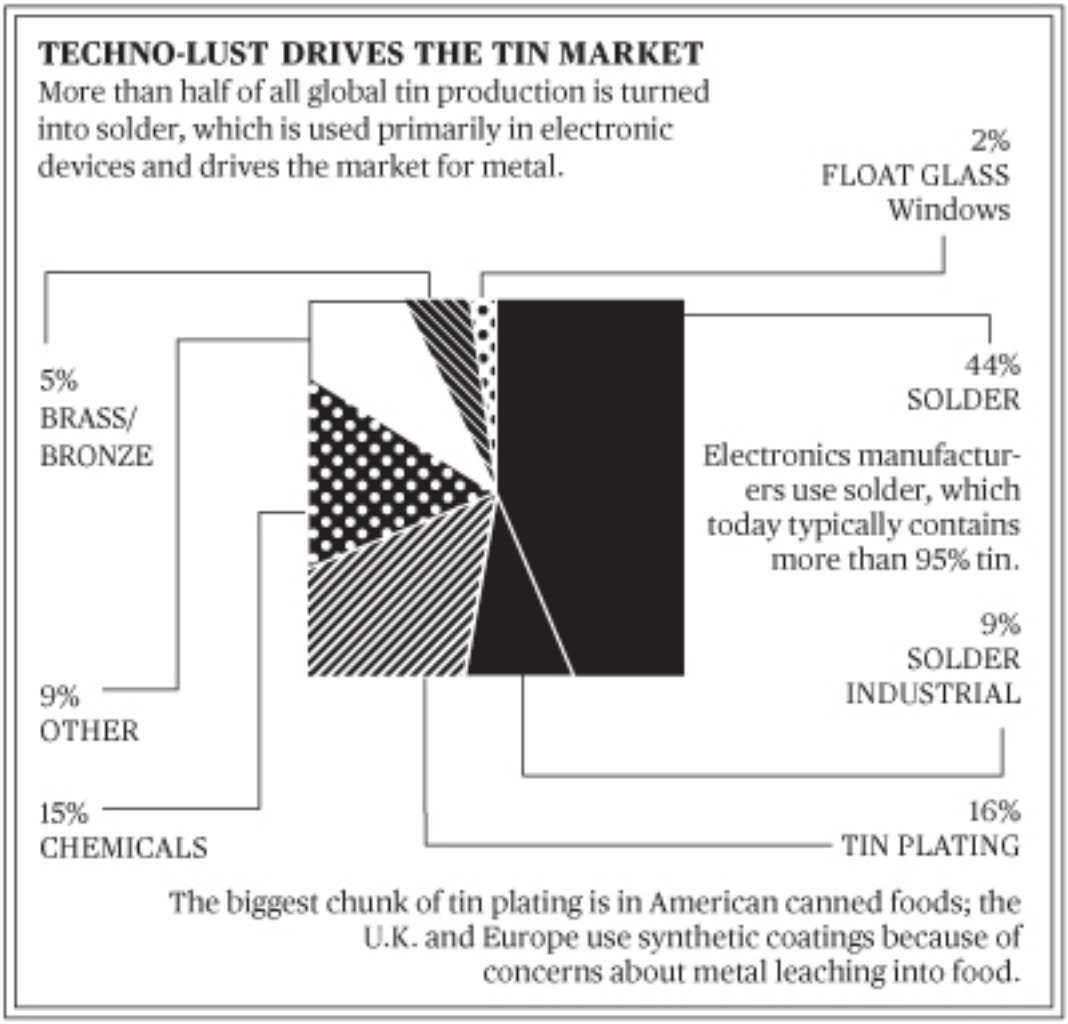
The buyer Murod in Pangkal Pinang

Murod is a Bangka native and a folk hero to many. As a young political activist, he helped Bangka and Belitung fight for, and win, self-rule in 2000, following years of provincial control from Sumatra. Self-rule was key to unleashing small-scale mining. After authorities in 2006 and 2007 tried to place controls on it, Murod helped organize demonstrations, which spun into riots. He was jailed and became a political martyr. The authorities relented.

Murod says it was his idea to bring in the dredges. “Like a money printer,” he says, speaking past a translator and breaking into English. During an interview at an outdoor café, he wears a short-sleeve dress shirt unbuttoned below the middle of his chest, exposing a long gold chain. At one point, he tries a joke in English, apologizing for his inability to understand a reporter’s accent. “I usually hear accent of Uzbekistan girl,” he says.

Until late last year, Murod was the secretary of an association representing independent refiners on the island, who supply almost half of Bangka’s exports. The rest enters the world market through two related mining companies: Timah, which is majority-owned by the Indonesian government, and a smaller company, Koba, which is a closely held partnership between Timah (25 percent) and Malaysia Smelting (SMELT [12]) (75 percent). The Indonesian government owns 65 percent of Timah, while the public owns the rest through shares traded on the Indonesian Stock Exchange under the ticker symbol TINS. Timah says it has almost 4,000 full-time employees and produced 11 percent of the global tin supply last year, making it the world’s largest integrated tin miner. But the people not reflected in those numbers are probably more vital to tin production. In 2010 the company said 98 percent of its onshore production came from independent, small-scale miners.

Timah has increased the number of small-scale sites in operation from 2009 to 2010 by close to 100 percent; reaching almost 4,000. Subcontractors run the pits, each with four or five miners, according to Timah's 2010 annual report. The company says all of its subcontractors receive safety training and are required to cut pits with shallow terraces, in order to avoid collapses.



METALS PRICE CHANGE SINCE 8/22/2007

COPPER	**TIN**	ALUM	LEAD	NICKEL	ZINC	STEEL
95%	**85%**	67%	60%	50%	51%	39%

Yet tin ore flows to Timah from communities and pits where miners were killed, where safety was ignored, and from obviously illegal operations, via tin buyers who work as the company's subcontractors in villages across the island. This does not surprise Murod. When questions are raised about environmental damage, or after a miner is killed, he says, Timah and the independent refiners tend to blame each other, or simply claim that the miners involved were rogues. Swatting his open palm back and forth, he likens it to a game of Ping-Pong. **Tjung Ling Siaw, 40, is a**

third-generation fisherman with spiky black hair, a wide smile, and a tattoo on his left arm featuring a woman wrapped in a snake. During high season, he spends 16 hours a day on the water, seven days a week. His wife and 5-year-old son live in a small house just off Bangka's Rebo beach, but Siaw sleeps on the water. He snoozes in turn with his crew, either on a massive trap floating 17 miles out, or on the 35-foot blue and red fishing prow he built by hand. Even after a productive night, Siaw is pessimistic about the future. "Being a fisherman is like gambling with your life," he says.

On May 29, the day Rosnan was killed, Siaw led a group of about 40 fishermen in a march to the gates of Timah's headquarters in Pangkal Pinang. They carried a banner declaring it was time "to restore people's rights" and accused the company of destroying their livelihoods. Today, Timah gets more than 54 percent of its tin from the sea, compared with just 29 percent in 2008. That jump comes with the addition of a fleet of dredges, called *Kapal Isap Produksi* in Indonesian, or KIPs for short. These are the boats that Murod likens to presses that print money. They are also the focus of the fishermen's ire.

For decades, traditional dredges sent mechanical arms with conveyor belts down to the sea floor. Buckets attached to the conveyors would scoop up the bottom and trundle it to the surface, one load at a time. The process was slow, clunky, and inefficient. The newer dredges use vacuums. The ships move easily, making it possible to find the most fruitful spots quickly. As Timah has expanded its fleet, its take of tin ore has more than doubled to 14,399 metric tons in 2010, up from 6,904 in 2008. The company's motto, and the title of its most recent annual report, is "Go Offshore, Go Deeper." Timah has about 50 ships on contract and 10 more of its own. There are also a handful of vacuum dredges owned by private refiners, such as Murod's.

On a hot afternoon in June, Reza Muftiadi, a 27-year-old dive master, pulls himself out of a swimming pool in Pangkal Pinang, puts down his air tank, and uses his right hand to squeegee the water off his face before extending it. Muftiadi, who teaches diving techniques to a pool full of young students, is a lecturer in the fisheries department at Bangka-Belitung University. He has studied and photographed reefs around the island and says they are being buried by sediment churned up in the quest for tin. Waters once deep and blue as the sky are now brown and silted over, Muftiadi says. "If there's no coral, it means there are no fish," he says. Fishermen say ship captains repeatedly ignore a prohibition on mining in waters within four miles of Bangka's shore.

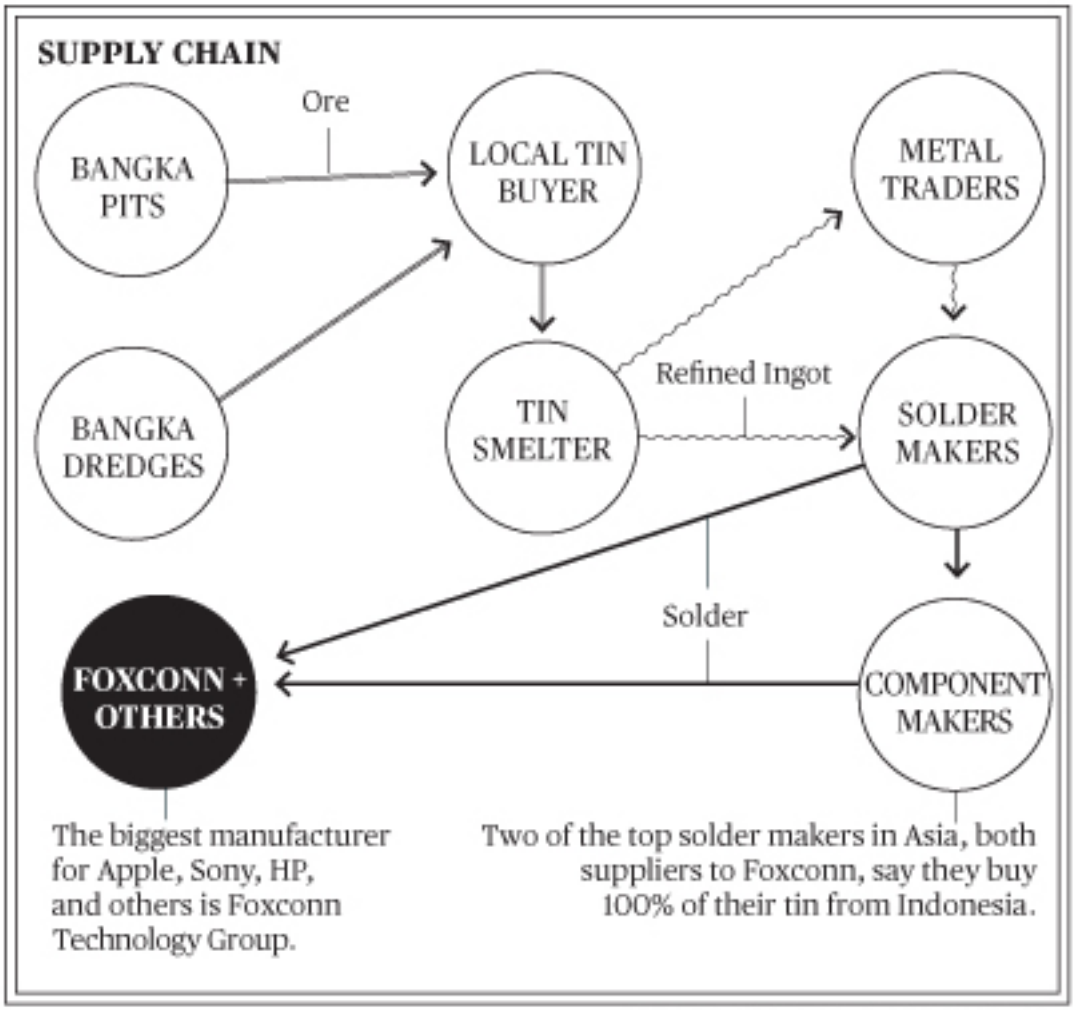
Tired of being ignored, the fishermen tried a new approach late last year. They teamed up with the local chapter of WALHI, an Indonesian environmental group, and sent crews chasing after the dredges with handheld GPS units and video cameras. With little effort, they documented illegal mining, says Ratno Budi, WALHI's executive director for Bangka and Belitung. Fishermen say illegal operations continue.

The corporate dredges are joined by countless small operators. In a seaside village called Batu Belubang, which is near the capital, 82 floating mines lined the sand or

the shallows along a half-mile stretch of beach. More were strung out along the horizon in all directions, their diesel engines providing a sputtering symphony as they mined the seabed. Each platform held a wooden shack with a thatched roof. Some carried names resembling call signs, such as “643 TIGER,” scrawled in black paint.

WALHI has estimated that there are about 2,500 such rafts mining the island’s coasts at any given time. Timah says these floating poachers “number in the thousands” and mine in waters where the company has exclusive rights. They are often manned by fishermen who have turned to floating tin mines to survive, according to Budi and others. Siaw, the fisherman who’s been leading protests, says he understands the difficulties that could force some fishermen to turn to mining, but insists he’ll never be one of them. “My philosophy is that I make my life from the sea. I can’t make my life destroying it,” he says.

Asked what the floating mines have meant for the village, a retired fisherman named Asis wrinkles his forehead. “We hoped it would build our infrastructure, but that was nonsense,” he says. “There’s nothing good for the community in this.”
The Saturday afternoon following Rosnan’s death, I go to see a man who was buying tin from the miners on the site. Awakened from an afternoon nap by his wife, Cikung, wearing a traditional sarong, invites me into the living room of his home, where a flat-screen television is airing soccer highlights. Cikung is bald and has a small pot belly. He sits on a couch next to a man summoned from behind the house, identified as his partner, “Billy.” Cikung then says that he is indeed the man who buys tin from mining sites in the area and that he is a subcontractor for Timah. Billy, sitting next to him, says the duo then sells the tin ore to both independent refiners and to Timah. Cikung agrees.



GRAPHIC BY BLOOMBERG BUSINESSWEEK

Moments later, Cikung changes his mind. He says he sells tin only to Timah and that Billy sells to independent refiners. Subcontractors for Timah are penalized if they sell ore from company concessions to independent concerns, who might pay higher prices in times of peak demand. The men then lead me through a small maze of rooms in a building connected to Cikung's house, and into a walled and gated compound in the backyard. The taste of metal and wood smoke fills the courtyard air.

Hot coals glow beneath what looks like a giant sandbox made of steel. Two men stand beside it, reaching in with rakes they use to spread wet ore across the bottom to dry it. Tin miners use water to form a slush around a vein of ore, which makes it easier to suck up with hoses. Stacked around the courtyard are propylene sacks holding more than four metric tons of ore. "You can't take any pictures," Cikung's wife shouts. Billy says he's not sure where all of this cassiterite was unearthed. "It's hard to know where the tin comes from, because when miners come to us, we just buy it," he says. He then displays permits for purchasing tin that he has from an independent refiner. "If someone comes to ask where my tin comes from, I just show that I have permits," he says. The documents are meant to entitle the holder to buy tin ore mined on specific, legally permitted areas, but Billy says he buys tin

ore regardless.

In a neighboring village between where Rosnan died and where 18-year-old Johidi bin Gunadi died, “illegal” small-scale miners say they sell their tin ore to another Timah subcontractor, named Rusmanti. Dressed in cargo shorts, a red Suzuki polo shirt, and a Guinness baseball cap, the 43-year-old pit boss, Rusmanti, explains that he has a Timah permit to run mines on about 20 acres (8 hectares) of company land. One of his pits is clearly safer than the ones where Johidi and Rosnan died. Its walls are low, and the pit is terraced throughout. Still, chunks of one wall slide into the water at the bottom of the pit three times during the interview. Of the dead miners, Rusmanti says, “They are illegal, they are not working for Timah. … If you work with Timah, you know how to do good mining.”

Moments later, however, Rusmanti acknowledges what the illegal miners in his village say: He buys their tin. When asked if he mixes tin from illegal mines with the tin his legitimate miners have unearthed, he answers, “Yes, I mix it. Timah will never know about this.”

Agung Nugroho, a spokesman for Timah, declined to comment on specific cases, but says the company will start instructing its small-scale mine operators to halt any tin buying from illegal and dangerous pits. A clear prohibition will be added to all future contracts, he says, adding that illegal mining on the island damages the company’s own operations.

The public prosecutor acknowledges that, at least in recent memory, the government has never charged the owner of a small-scale mine, a pit boss, a tin purchaser, or anyone else in the supply chain following a deadly pit collapse. “Government, no responsibility. Timah, no responsibility. Smelter, no responsibility,” Murod says, adding, “We are all the thieves here.”

Murod says change is overdue. Independent smelters and the mining companies should be forced to pay a share of their revenues into a fund that would be administered by an independent group to improve safety, provide insurance for miners who are killed or injured, and to remediate environmental damage, Murod says.

The companies that dominate the world solder market—such as Cookson; Henkel; Metallic Resources, of Twinsburg, Ohio; and Indium of Clinton, N.Y.—are not completely in the dark. Five years ago they expressed alarm about illegal mining. But they were concerned that a crackdown by Indonesian authorities was driving tin prices up. On March 12, 2007, following one of the first big price spikes for tin in the last decade, a group called the Solder Products Value Council issued a public statement. It complained that tightened Indonesian export regulations and the crackdown on “illegal mining operations mostly in the Bangka-Belitung province” were behind the spike, declaring: “A key to our industry’s growth will be how we address these dramatic cost increases without driving the Assembly Electronics supply chain to yet another dangerously low level of profitability.” Members of the group say they control more than 80 percent of the global supply of solder for electronics. In a statement this week, the group said it doesn’t endorse illegal

mining and supports all efforts to eliminate it.

It is not the first time tin buyers on the island have been indifferent to the local costs of global demand. Bangka has only one building dedicated to preserving history, the Indonesia Tin Museum. It spans four small ground-floor rooms in what used to be the residence of the Dutch colonial mining boss. Schoolchildren on field trips regularly crowd before its glass cases, peering in at hand tools, spools of solder, or a plastic model of a dredge suspended on a faux sea.

The museum's dominant feature is a mural painted across a concave wall like a diorama. The painting shows more than 70 islanders scattered across a vast pit, most hunched over rakes, or stooped under the weight of ore suspended from the tips of shoulder poles. Standing front and just off-center is the Dutch colonial boss. Shaded under a parasol held high by an islander, the boss's back is turned to three miners, who are only a few feet from him. Two of the men are acting as human crutches, assisting a comrade unable to stand on his own. Shoulder poles are a rare sight at Bangka's tin pits these days, and there are no Dutch masters. Otherwise, not much has changed; if anything, the terracing shown in the 19th century pit is an improvement.

Dian Chandra, Rosnan's son, says he blames no one for what happened to his dad. "I just accept it as a fate," he says. He sometimes accompanied his father to the tin pits, sleeping in the makeshift camps miners erect from tarps and palm branches along the pit rims, so he could help his dad dig for tin at sunrise. As he spoke, his mother was mining tin in the pits nearby, as she had been when Rosnan died. "I told her not to go mining again, and to let me look for a job," he says. "I want to make her happy, and I'm worried that something might happen to her."

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