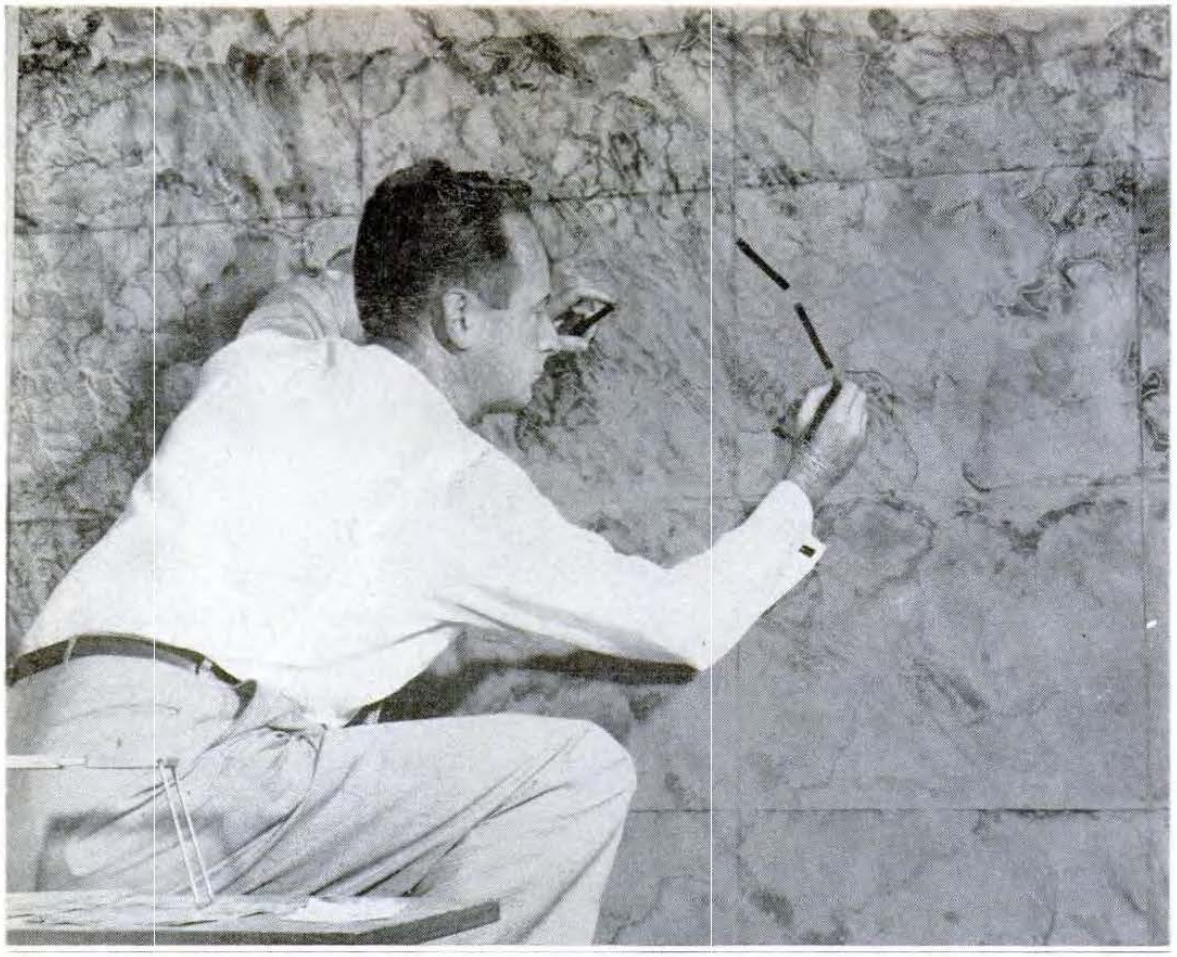
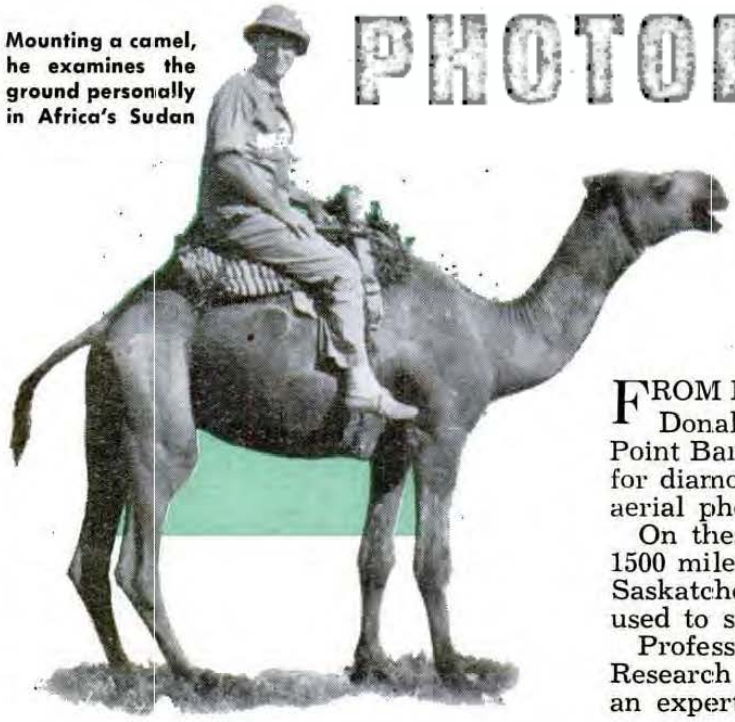


Belcher analyzes photos covering 19,000 square miles to locate best sites for Brazil's new capital city

Report on a New Profession: PHOTOANALYST



Mounting a camel, he examines the ground personally in Africa's Sudan

From interpreting aerial photos for MacArthur, this professor has turned to prospecting with air maps. He can find you an oil well or anthill

By William Gilman

FROM HIS ARMCHAIR at Ithaca, N. Y., Donald Belcher can prospect for oil at Point Barrow, Alaska, for water in Iran or for diamonds in Africa, using nothing but aerial photos.

On these photos he can spot an anthill 1500 miles west in Wyoming or a stone in Saskatchewan which an ancient buffalo used to scratch its shoulder.

Professor Belcher, head of the Airphoto Research Center at Cornell University, is an expert at reading faraway clues from

photographs. He uses only his bare eyes and unenlarged, nine-inch-square photos taken about 10,000 feet up and showing nine square miles. He works with overlap-stereoscopic photos that bring out depth, and normally prefers up-to-date ones, but can use ordinary air-survey shots 20 years old.

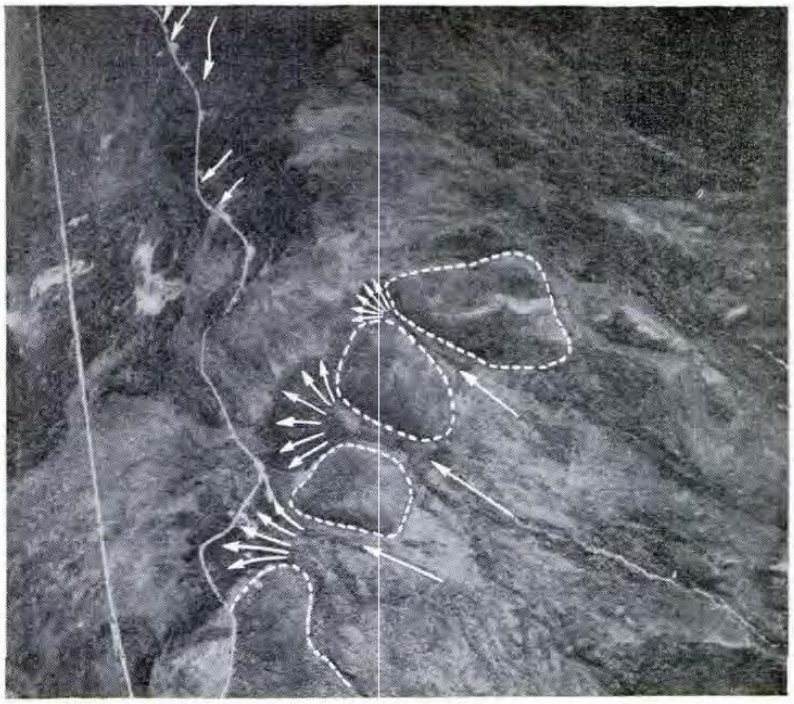
His secret is that he uses simple facts from such sciences as geology and botany, and works over the photos with the skill of a Sherlock Holmes.

For example, disturbed earth can show effects for years, even centuries, so you don't have to see the earth itself if it's covered with vegetation. On the ground you may not notice it, but grass grows greener in damper soil, and it shows up clearly from the air. That's how dark lines in English air photos were revealed to be remains of prehistoric ditches dug by natives before the Celts. A pedestrian would never notice them.

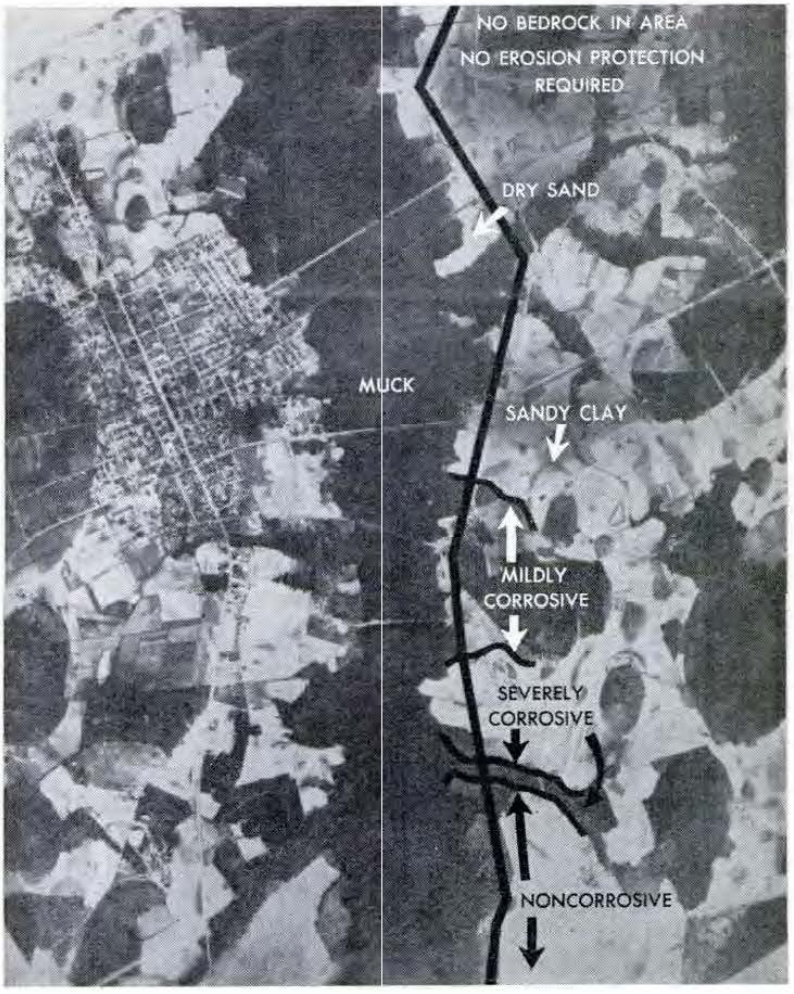
One of Belcher's special jobs has been to locate dangerous land mines left underground in World War II. The man afoot does not notice it, but the replaced soil over the mine remains slightly drier. And Belcher spots that lighter-colored soil or vegetation.

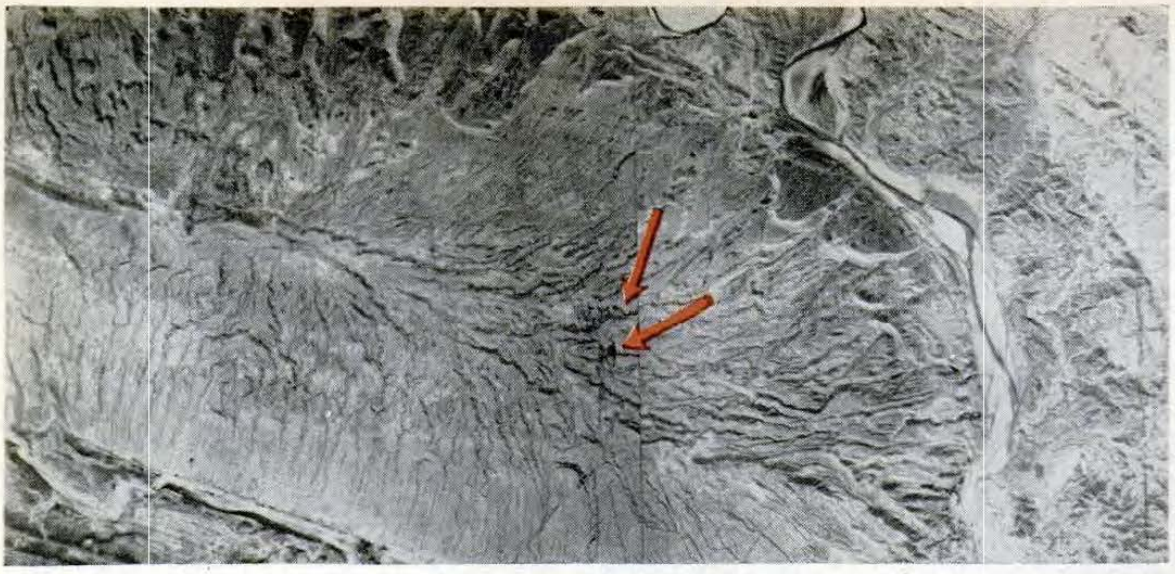
One of his photos shows a puzzling pattern of thin white lines. They're nothing but ordinary clay draintiles buried four feet underground. Above them the ground is drier, and the grass and corn grow a lighter green.

About that anthill in Wyoming: Belcher explains that it may be only the diameter of your finger, but around it is a clear area of sand a few feet across. This whiteness is outlined by a deep-green ring of grass. Result



White arrows indicate natural erosion that might destroy old Canadian road. As result of study, new straight road was built as shown at left. Dark line (below) indicates Belcher's recommendation for pipeline route to reduce costs and repairs. Corrosive areas may cause trouble in future





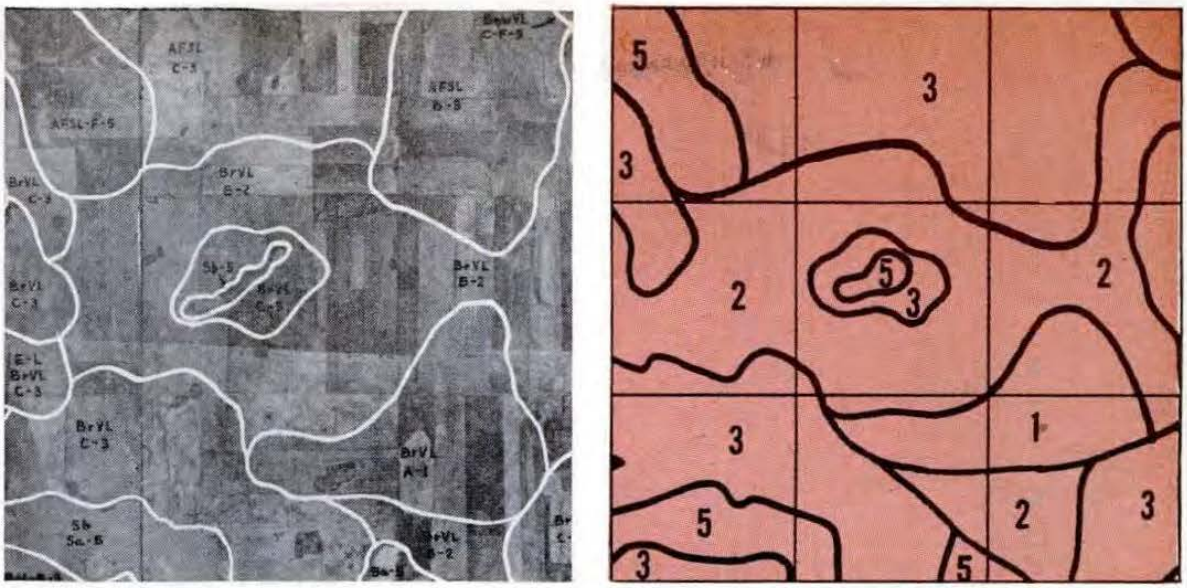
Oil find was made from thousands of miles away. Arrows show cracks through which oil flows to the surface

is a distinctive small dot in the photo. Belcher filed this item away in his memory 16 years ago when he was choosing airport sites for the CAA. His mind is full of such nuggets of information.

If he notices something he can't explain, it bothers him until he finds out what it is. In Saskatchewan air photos two years ago, he easily spotted large boulders on the ground. Some were very shiny with dark rings around them. They were a puzzle even to Belcher.

Next time one of his men was in western Canada, Belcher had him detour to the region. He found the rocks polished smooth. Around some were circles of very hard-packed ground which had shown as the dark rings. Local history explained the rest. Back in buffalo days, the beasts had rubbed their itchy hides, stomping round and

Middle East oil dome is easy to recognize—a long, upturned rock structure that resembles a whale on the sea



From air photo at left, analysts made land-use map at right. Lowest numbers indicate the best farm land

round the rocks in the area.

In Belcher's African work, a dark circle about two miles in diameter can mean a "pipe" of blue clay—the kind extending to depths where diamonds are found. Ordinary prospectors plow furrows across the land in hopes of uncovering telltale clay. Belcher can spot the darker vegetation that grows over impervious clay at a glance.

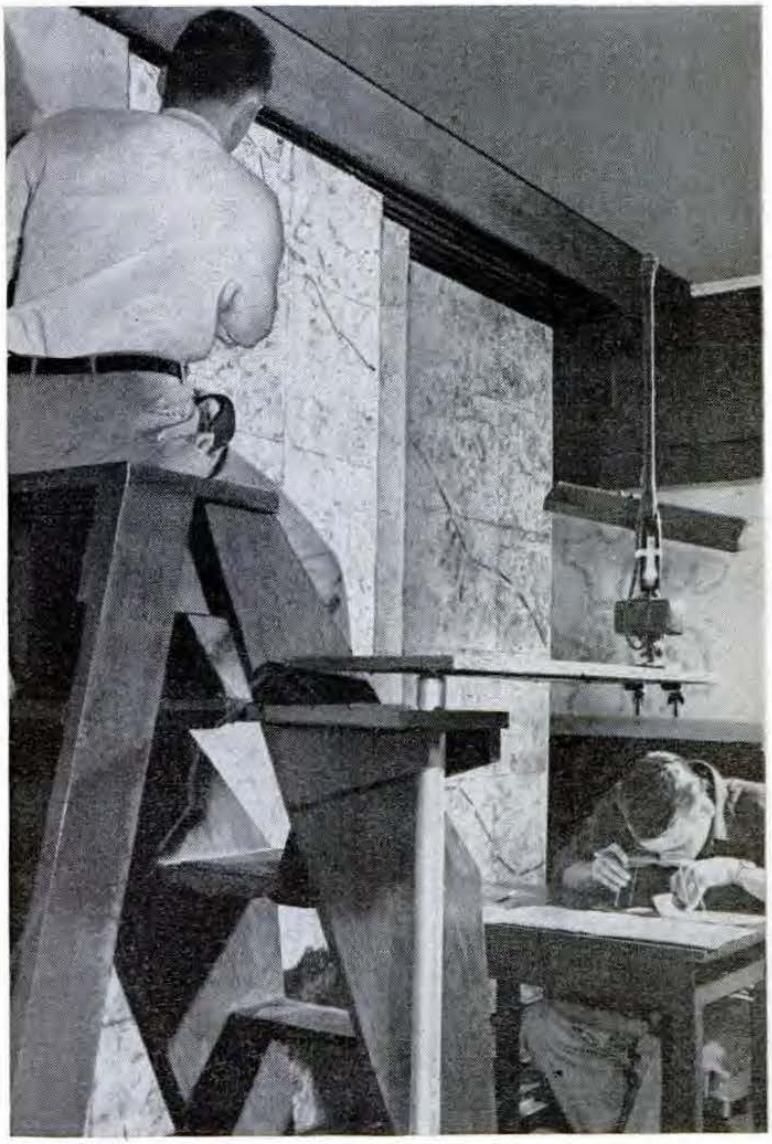
That's a special case. For most work, Cornell's expert has developed a list of 32 standard land forms which he calls "familiar faces"—sand dunes, rock formations, gravel terraces and other features.

In addition to his Cornell work, Belcher now has his own consulting firm, D. J. Belcher & Associates, for private jobs. These run all the way from $300 to locate gravel for a township's roads to a $500,000 fee from Brazil to have Belcher's outfit pick the right place in the wilderness for that country's new capital city.

Yet 11 years ago he was still trying desperately to convince the Pentagon that his air-photo interpretation methods were needed in the war. He was then 33, a junior-grade professor of civil engineering at Purdue.

(Continued to page 240)

Sliding panels are covered with mosaic of Brazil wilderness. One analyst studies stereoscopic prints, another transfers findings to mosaic



Report on a New Profession: Photoanalyst

(Continued from page 121)

On New Year's Day, 1944, thinking over his glum prospects, young Belcher blew up with impatience. He airmailed a letter direct to Gen. Douglas MacArthur in which he declared how necessary he was to the Pacific campaign.

Back came a batch of air photos and the challenge, "Prove it."

He spent the week end marking them with circles and arrows, and airmailed them back with his analysis. Meanwhile, U. S. Marines were making a strategic landing at Cape Gloucester, New Britain, and getting badly bogged in a swamp their maps hadn't warned them about.

A few days later Belcher's samples arrived. They showed his warning finger pointed at the dismal swamp.

In two weeks, Belcher was flying the Pacific to become a civilian intelligence expert.

Compared to other things he's done, Belcher says spotting that swamp was pretty simple. In the photo he saw volcanic slopes coming down toward the sea, but there was a rise along the shore line. Obviously then, this formed a pocket and this pocket would be a catchbasin for water and washed volcanic soils—a fine mess of goo.

That was the "hard" analysis. Belcher could see the swamp another, easier way. It showed up as a much darker area, meaning a heavy growth of trees using lots of water.

It was dramatic proof. Before the war was over, Army engineers switched him north to Alaska, then the R.C.A.F. borrowed him to analyze a wild belt of northern Canada from the Mackenzie River to Labrador.

To date he has worked in 23 countries and all 48 States. He has added projects for our Navy and Signal Corps, and some of the work is obviously hush-hush. He pops up in West Germany one week, Burma a week later.

Some of the travel is to check finer details. Some is to get personally acquainted with unfamiliar terrain. Other times he wants to be there to see that his instructions are followed correctly.

In Iran, for example, he had to outwit local potentates who wanted water for their own luxury needs instead of for the general public. It was there, working on a UN assignment, that Belcher and his men produced 50 well sites in that many days.

Most of them were in a valley which had

(Continued to page 242)

been Persia's bread basket 2000 years ago. Now it was desert. But from the slant of rock walls in the bordering mountains, Belcher knew that—despite the layers of rubble and sand—the ancient stream still flowed below.

When he arrived Belcher confidently bet his own Western clothes against a sheik's costume that he'd find water for that tribe. When he left he was wearing the sheik's outfit.

At times Belcher's technique has been challenged and he has shown people what was in their own back yard.

One town desperately needed gravel for roads. Belcher discovered an extension of an overgrown pit forgotten for many years. Another time he asked his assistant, L. E. "Red" Gregg, now Technical Director of Highway Research in Kentucky, to bring a sand-dune sample back from a New England township. (By collecting sands, Belcher has worked out a method of telling the size of sand particles from air photos.) The local road engineer insisted, patiently and then in anger, that there was no such sand deposit a couple hundred feet off the highway.

"I helped build this road. I've patrolled and inspected it hundreds of times the past 20 years. I ought to know if there's any sand around," he snapped.

But the sand turned up right where Gregg expected—covered by a growth of trees. Their lighter-colored leaves in this dry place was the tip-off.

Belcher reached a village in west Canada and hired a taxi. He said he wanted to be driven out of town past a certain bridge and dropped at a trail off the Alcan Highway.

"I've got some soil-testing to do along that trail," he said. "I'll follow it around and come out where it hits the road again."

The native stared and said, "You never been here before, have you? Well, I've hunted every trail in this country the past 13 years, and there's no trail there."

But there was. Belcher led him on to it —a faint animal trail that enlarged where the brush was thicker.

The driver grabbed Belcher's air photo: "Mean you saw this on the picture?" The "greenhorn" professor showed him the spidery line.

Even before Belcher, of course, aerial surveying had revealed how much more you could see, and faster, with a plane's camera. And there had been a start in prospecting. Spying oil "domes" by air and sensing certain ores by magnetometer have become standard practices.

Belcher's original contribution is going

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down right into composition of the soil. Now he is developing the spotting of uranium or iron possibilities by color differences in earth or vegetation. Prospecting is one of his newest services.

With photos Belcher has given landslide warnings to railroads and others. For example, New England builders planned to set one end of a dam on what seemed good footing. Actually it was an earth layer resting on a slippery, tilting layer of underground clay—an ideal setup for tragedy.

He's also consulted by companies laying great pipelines. His diagnosis directs them to a right-of-way that will have a minimum of rock and corrosive soils.

Belcher's first Alaskan assignment was to find out why Northway Airport was badly stuck in the mud and how to correct it. He advised a better location—the runways had been built over sandy permafrost. When uncovered by bulldozers, this perpetually frozen subsoil acquires a top layer of mud thawed by the sun.

The U. S. and Canada then shared his services for several investigations in the far north. He located all sorts of things—oil structures, townsites, airport sites. Recently his staff began a complete study of terrain around Fort Churchill, the busy center of activity on Hudson Bay.

Belcher started locating permafrost depths with a steel penetrating rod but soon had the aerial clues he wanted. Black spruce and tealeaf willow are his indicators of ground wetness, which means bad drainage, the tip-off to impervious frozen soil. Of the two, the willow is superior.

Where the willow grows densely, he knows its water-thirsty roots are doing fine, so permafrost doesn't start above a four-foot depth. Where trees are scattered along with grass, the frost begins at around two feet. In low terrain without the willow Belcher has his warning—permafrost within 18 inches.

Can a photoanalysis skill like his be taught? One answer is the class of around 40—from all over the world—who study under Belcher at Cornell. Another answer is the system of branch-training programs. There's one now in faraway Burma which Belcher set up, then turned over to assistants.

Here's a new science with practically no special tools. For mineral prospecting and some military work, Belcher might use special film emulsions to study foliage or to pierce camouflage, or infrared to penetrate long-distance haze or darkness. This red, when used in forest photography, is also handy for differentiating one tree species from another.

(Continued to page 246)

POPULAR MECHANICS

Otherwise his work these days is done with ordinary overlapping air photos and a stereoscope costing only $10.

He says the most important requirement is a wide-open mind and groundwork in more than one of the standard sciences. That's why he mistrusts specialists. You might expect a professional cameraman or engineer to be fine material. Exactly the reverse. Belcher says the "disciplined imagination" he requires is more likely to be found in a landscape architect.

In one of his foreign jobs, a $200,000,000 dam-building project, he sat in Ithaca and located gravel for mixing concrete, and clay for facing the dam. It was easy. Despite heavy forests, Belcher noted typical erosion gullies. A V-shaped nick meant the quick drainage of gravel. Longer, thinner ones meant the slower runoff from clay.

Belcher was astonished later to receive a geologist's report that clay wasn't there. With Dr. Ta Liang, his ace assistant, he grabbed the first available plane and rushed to the dam site at his own expense.

They cut their way through wilderness to the place where Belcher's "X" had marked the spot for clay. And they turned up 4,500,000 cubic yards of it.

Belcher got his bachelor's degree from Purdue in 1934, year of depression, and recalls that jobs were rare.

He studied shorthand and typing to make himself more useful and finally got on a Purdue highway-research program. That meant much outdoor work with soil maps.

One day in 1937, a friend working in soil conservation was cleaning his car. He gave a bundle of old aerial photos to Belcher, who tossed them into his own car and forgot them.

A few weeks later, on highway work, he got caught by rain. Sprawling in the back seat, he unrolled the air photos. Then, remembering he had soil maps for the same region, he started comparing them. Each showed the same streams, roads, houses.

Then he noticed a "funny round area" that was exactly the same on map and photo. It was an area of "Wisconsin Till"—one of those rich corn-and-hog gumbo soils. It had been drawn on the map after much trudging on foot for soil samples.

A click of the shutter in an aerial camera had done the same thing. In the photo, this area showed a darker color.

That was the beginning. Belcher gathered more proof. The CAA heard of his work and borrowed him to locate future airports. For example, his analysis showed Springfield, Ohio, how to save $502,000 by building over solid gravel rather than a badly drained site—and have its airport about four miles nearer the center of the city.

(Continued to page 248)

Then he began showing builders of highways and railroads how to avoid bad soils and muck traps. When the war came, he wanted to see his build-up of clues and technique used by the Army. But he couldn't arouse interest.

He saw a chance one day when Wright Field published a night photo taken of open countryside.

"I recognized the soil pattern at once," Belcher recalls, "the way you would recognize an old friend in a strange city. It was typical of a narrow belt from Illinois across Indiana into lower Ohio. With county maps I narrowed it down and found the exact spot."

He informed Wright Field. Officials there were impressed but had to admit they couldn't confirm Belcher's location—their fliers had just banged away with the camera.

However, the story spread that Belcher could tell amazing things from air photos.

Belcher kept trying, and finally the campaign in the South Pacific gave him his chance to make good.

It's the Brazil job that's displaying his virtuosity right now. Since 1789, Brazilians have dreamed of a great new capital city. Fifty years ago they set aside their "Future Federal District"—19,000 square miles of wilderness, most of it healthful upland 500 miles from Rio de Janeiro. But how to explore so vast a region with speed and accuracy?

Belcher was called in last January. A flood of air photos reached his Ithaca office. Out of the blacks, whites and grays he was to select sites for not one but five capital cities—Brazil would make the final choice among them.

Each city site was to be a full package. Belcher had to think of streets, of transportation by rail, air and highway. There had to be water for homes, factories, offices and power generators. The site had to have the right kind of rock on which to erect skyscrapers, also had to have loam for home and commercial gardeners.

Belcher's staff cut the photos to eliminate distorted parts and ended with a mosaic from floor to ceiling, covering both sides of nine sliding panels. To this mosaic was transferred the analysis made on 3-D prints by Belcher and his crew.

By July, when other Belcher crews went out into the wilderness itself to make spot checks and contour maps, not a shovel of earth had been turned. Yet Belcher and his short-cut explorers had chosen and roughed out the sites for five spanking-new cities—work that otherwise would have taken years. ★ ★ ★

REPORT ON THE '55 PLYMOUTH

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