

JOURNEY VIA OTJIWARONGO ^{The DAVID DUNLAP OBSERVATORY}
A TRIP TO THE HOBA METEORITE

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Introduction. Among the major meteorites known on the earth, few can have received less attention than the Hoba meteorite, especially since it is the largest of all. It lies where it fell, near the little village of Grootfontein in South West Africa, and to the best of my knowledge has been visited only once before by an astronomer, Willem Luyten, who has given an account in *Popular Astronomy* (vol. 30, p.13, 1930) of that visit thirty-seven years ago.

On hearing that I was planning a holiday in South Africa during the (northern) summer of 1966, Dr. D. A. MacRae suggested that I might consider making an excursion into South West Africa to see the Hoba meteorite, if only to bring back some modern pictures of it and its surroundings. I confess that my initial reaction was only lukewarm, since Grootfontein is remote from any area I had intended visiting, and travel in South West Africa is often inconvenient, to say the least. As it transpired, however, this visit proved to be exceedingly interesting and frequently exciting, and I am most grateful to Dr. MacRae, both for his suggestion and, more materially, for a travel grant from the Walter Helm Fund of the Department of Astronomy, University of Toronto.

South West Africa. The Territory of South West Africa comprises about a third of a million square miles in the form of a rough rectangle some one thousand miles from north to south and several hundred miles east to west. The Kunene and Okavango rivers separate it on the north from Angola; the Orange river to the south forms the border with South Africa, 500 miles north of Cape Town. To the east the beginnings of the Kalahari Desert mark the border with Bechuanaland (now Botswana), and the grim desolation of the Atlantic's Skeleton Coast is the western border. Like all of southern Africa, the land rises sharply on going inland, and most of the territory is several thousand feet above sea-level. This, and the extreme dryness of the air make for a very bracing climate in the central highlands. In the northern parts, deeper in the tropics, where rain is more plentiful and the land starts to dip towards the Congo basin, the climate is less healthy. Malaria and the tsetse fly have not yet been eradicated.

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FIG. 1—South West Africa in relation to surrounding countries.

Almost unknown to tourists outside southern Africa, South West Africa holds much of interest to the visitor, be he of a hardy disposition. For several hundreds of miles along the coast stretch some of the richest diamond fields in the world. Curiously, these diamonds are almost all of gem quality and show a strong gradation in size from north to south along the coast. Since they are only lightly buried in the desert sands, entry into this area is forbidden to all who do not hold the necessary permits. The origin of the diamond fields is unknown; whether they came from prehistoric rivers washing down to the sea, or whether the diamonds have been washed up from the sea itself is only speculation. Certainly throughout the Territory there is plenty of evidence for ancient volcanism: there are numerous hot springs and occasional remnants of cinder cones; semi-precious gems like amethyst, topaz and tourmaline are to be found, and the sea-bed off the coast is still in a state of active volcanism, with sulphurous islands sometimes emerging above the surface.

Along the coastline stretches the Namib Desert, sometimes known as the 'smoking' desert because of the sand perpetually blowing off its dunes. Road maps of South West Africa show thousands of square miles of this area as a blank, with the simple statement "constantly shifting sand dunes". The highest dunes ever measured are located here, some of them 850 feet from trough to crest. Interestingly, the Namib is rapidly encroaching into the ocean, at places as much as 50 yards a year—almost a yard a week! Large ships which were wrecked in the surf (the name Skeleton Coast is well-given) only twenty or thirty years ago can now be

found almost buried in sand half a mile or more inland. There are even the bones of a sixteenth century galleon in the desert, its story unknown. In the southern part of South West Africa the Namib turns inland to meet the Kalahari Desert, so that between them they form a horse-shoe around the Territory. This means that in going from South Africa into South West Africa one must cross this southern tongue of desert, a fact I was later to rue.

Not far from the south-eastern corner of South West Africa are the Aughrabie Falls on the Orange river, one of the five largest falls in the world. Here the Orange, largest river in southern Africa, is confined in a narrow and tortuous rocky channel through which it roars with stupendous ferocity and noise to crash 600 feet down into a violently turbulent pool below. So confining are the sheer rock walls that air trapped under the falling water builds up to explosive pressures and periodically, with a bang heard even over the shattering noise of the upper river, water is exploded up and out down the lower canyon. Since the Orange is known to wash diamonds down to the sea, it has been surmised that an immensely valuable collection of diamonds may be trapped in the pool under the falls. Not surprisingly, none has been recovered.

Just east of the Namib in the southern portion of the Territory lies the Fish River Canyon, which, although smaller, bears a remarkable resemblance to the Grand Canyon of Arizona. Three thousand feet deep and about ten miles across, it has been cut by a river that now only flows occasionally, after torrential downpours in the rainy season. Remote and inaccessible, it is only recently that a trickle of tourists have come to visit it, and even now the journey is not a pleasant one.

Almost a thousand miles to the north is the Etosha Pan Game Reserve, some 25,000 square miles in extent. The Pan itself is the dried up bed of an ancient lake about 85 by 45 miles in size, and surrounding it is to be found a considerable variety of big game, including lion and elephant. It is the development of access to this excellent Reserve which is now thankfully leading to a great improvement in the roads of South West Africa.

Also in the north, near Otjikoto, are the only two lakes in the Territory. Quite small, they are surrounded by high dolomite cliffs, and their aura of mystery has made them the source of many legends, among which is that they are bottomless. They are, in fact, several hundred feet deep, and are interconnected both with each other and with a vast underground watertable.

The people of the Territory are ethnically very diverse, but everywhere friendly and hospitable. The non-white races total about 450,000, and include Bushmen, Damaras, Namas, Hereros, Ovambos, Tswanas

and many others. The Bushmen are an extremely primitive nomadic desert people, and most of the others appear to live traditional tribal lives in remote parts of the country, apparently entirely unaware of the political furor raging over them in other parts of the world. There are about 73,000 white people, around two-thirds of whom are Afrikaans-speaking and one-third German. English is seldom spoken, and I was relieved to find that my Afrikaans could still withstand simple conversations.

Although little of it appears in history books, South West Africa has had a lamentably bloody and violent history. The early inhabitants were mainly Bushmen who were later invaded by various Bantu tribes from



FIG. 2—Entering the southern Namib desert.

the north, Hottentots from the south, and Germans from the coast. The Bushmen retired to become masters of the desert, and left the remainder to be fought over in bitter three-way wars which persisted into the early years of this century. For about thirty years South West Africa was a German colony, but since the First World War has been a Mandated Territory administered by the government of South Africa, a matter presently under dispute.

The overriding impression of South West Africa is one of great aridity. Except on the borders there are no perennial rivers, and a patch of green almost nowhere to be seen. It is a hot and dry land, with vast panoramas of desert and semi-desert, blue granitic mountains seen at immense distances through the clear air, harsh areas of broken rock so unrelieved as to be almost painful to contemplate, and in the north endless miles of

rolling savannahs covered in brown grass and stunted African bush. There is little beauty, but great grandeur.

The Journey. My original intention had been to fly to Windhoek, the capital of the Territory and a regular port of call for South African Airways, and then go by a small local airline to Grootfontein. Shortly after my arrival from Canada, however, I attended a party in Cape Town at which a long-standing friend and ex-neighbour of mine, Mr. Alex Bain, was present. On hearing of my proposed visit he asked whether I would be interested in going overland, since he had a car, could obtain a week's leave, and would very much like to visit South West Africa himself. I gladly accepted, since this would make the visit infinitely more interesting, and South West Africa was the only remaining area of southern Africa through which I had not already travelled. Other friends were more skeptical and drily asked what make of new car Alex proposed buying on his return, since the appalling condition of most South West African roads is well known. Even the down-to-earth South African Guide and Yearbook gravely counsels that car travel to South West Africa is not general and should only be undertaken after due consultation with the major travel associations. In fact, we were to find that one such association seems unduly optimistic over car travel in South West Africa; its road map at one point shows a major highway where none exists (actually it is a proposed highway, we learnt), which added complications to our travel on one day. However, with undiminished, if brash, enthusiasm we laid our plans.

South Africans are fond of quoting Sir Francis Drake's reference to the Cape Peninsula after his round-the-world cruise in 1580: 'For 'twas the fairest Cape that we did see in the entire circumference of the Globe'. Fair it is indeed. Today, a city of almost a million people, known for its culture and history, surrounded by mountains, sunny vineyards and blue ocean. Among its less attractive moods, however, is the wet, windy, weather of its winters, and during July of 1966 a cold, drizzling rain fell on every day except three. The thought of a week in the tropical desert-like conditions of South West Africa was one to gladden the heart, and it was with considerable anticipation that Alex and I drove out of Cape Town in the late afternoon of August 5.

The first few hundred miles of the road northwards is at a slight angle to the coast, and we travelled steadily inland among the soft, verdant hills as they roll down to the sea. Within an hour or two we glimpsed through the clouds to the east the snow-capped peaks of the Winterberg mountains, among which is the farm Winterhoek. In the last century, a

renegade Hottentot chief, banished from here, settled in the middle of South West Africa and nostalgically gave to his settlement the name of the farm from which he had come. It is today the capital of the Territory, with its name corrupted to Windhoek.

It is only when one crosses the Elephant river, its banks dotted with citrus farms, that the character of the countryside starts to change. The hills become more harsh and rugged, the grass less green and more sparse. The remote mistiness vanishes. And before long the excellent paved highway abruptly ends and one is adrift on a narrow, twisting rock-ridden road that vanishes among the hills to the north. It was in these hills during the sunny morning of our second day that one of our few misfortunes befell us. With more than three thousand miles to cover in the week, and most of them over roads expected to be awful, we drove at high speed whenever we could. Speeding along over this rough road we could hear the stones bouncing up under the car, and unknown to us at the time, one of them cut a small gash in the gas tank. Congratulating ourselves on the good time we were making, unaware of the gasoline slowly dripping out behind us, we raced on towards the 250 miles of desert we intended crossing before nightfall.

Our misfortunes were always balanced by a remarkable turn of good fortune. There was one more little town before we were to cross the Orange out of South Africa into the desert, the settlement of Springbok in Namaqualand. Since it was the last village we expected to come to until late afternoon, we fortunately elected to stop for an early lunch. Emerging after half-an-hour over indigestible backveld hamburgers and coffee, the strong smell of gasoline and the tell-tale stream trickling out from behind one of the rear wheels were only too obvious. What to do about it was less obvious. Automobile repair facilities do not abound in Springbok, and besides, it was a weekend, during which the Afrikaner shuts down his small town with all the absoluteness expected of the rural Puritan. Gasoline may be purchased through the reluctant services of an indolent hired-hand, but a mechanic is no more to be found than an astronaut. However, our malady was a not uncommon one in those parts, I suppose, and in due course we came on a large gentleman who hardily climbed under the car and examined the leak without removing his lighted cigarette from his lips. A man of few words, he went away and came back with a handful of dates. He spat on these and squashed them to a pulp, and then to our growing incredulity, climbed under the car and clapped them over the gash. As he dusted himself off he assured us in Afrikaans that the dates would react chemically with the gasoline and soon be rock hard. What, we enquired with considerable skepticism,

if another stone knocked the wad off when we were a hundred miles out into the desert? He shrugged slightly. "Walk back", he said, "and I'll give you some more dates". We crammed the cubby-hole half-full of dates, and thus insured, set off for the desert.

Taking no chances, we stopped an hour later to top up at the last gasoline pump in South Africa. Persistent honking of the horn produced a sleepy and irritable youth who had difficulty starting up the generator which produced electricity to run the pump. It seemed that traffic through the desert would not be heavy. Investigation also indicated that the chemical reaction of dates and gasoline was a slow one—gas was still oozing out of the tank. We paused briefly to view the Orange river we were about to cross, but in this, the dry season, it was unimpressive. For its final few hundred miles down to the sea this river gets steadily smaller and shallower, losing more water by evaporation than it gains from tributaries. Even so, its banks had almost the last greenery we were to see for the next two thousand miles.

Interestingly, there is nothing, not even a road sign, to tell one that one is technically crossing an international boundary at this point.

Over the bridge the road became generally worse as we started the long climb up from the river. Since we were now entering the eastern tongue of the Namib, even the scrub bush began to give way to nothing but brown gritty dust, so that at times it was difficult to differentiate road from desert. In places the road was remarkably good, and unconsciously one would soon speed up to 50 or 60 m.p.h., only to find that here and there the dust obscured stretches of corrugations which sent the car sliding wildly sideways and left the steering without response. South West African roads also have a habit of undergoing sudden dips, several feet deep and perhaps twenty or thirty feet across, into which the unwary plunge with a tremendous crunch of springs and shock absorbers and often a painful bump of the head on the car roof. We met oncoming traffic at the rate of perhaps one car an hour, and the only thing to be said in favour of the road is that an oncoming car can be followed all the way up from the horizon by its column of dust. On the other hand, one is totally lost in the choking dust for a few seconds after the car passes, and overtaking another vehicle is quite a serious business for the same reason.

Almost a hundred miles north from the Orange the approaching hills began to take on a bright golden appearance, like distant wheat fields seen in sunlight. These soon revealed themselves to be true sand dunes, and the road began a series of tortuous turns to avoid the worst of them. It was evident that the road is sometimes completely inundated by the

wind-blown dunes, and then a new one has to be cut through the troughs. The road we were on seemed about to suffer that fate because we soon began to feel the thick, coarse sand tugging on the wheels. As we came spinning around one dune, the road collapsed for fifty yards into just isolated tracks through the sand, and with a sudden sideways lurch our car was solidly stuck. The reason why most of the oncoming traffic had been four-wheel-drive vehicles was now painfully obvious. We got out and surveyed the situation. I was overwhelmingly struck by the utter, absolute silence that prevailed. Only the eerie whining of the wind over the sand would occasionally break the complete stillness. We were now, in fact, almost out of the dunes, but scanning ahead with binoculars revealed no sign of habitation, or indeed, any living thing. A little experimentation quickly revealed that we were unlikely to get the car out by ourselves, and meanwhile the gasoline continued to ooze unabated. It was a moment that I shall count among the less happy ones of my life, although, in fact, we were not in any real danger. Being mid-winter, the temperature was only a moderate 75° or so, we had a gallon of drinking water with us, and at worst we might have had to spend the night in the car. But again our misfortune was paced by good fortune. We had been there no more than half-an-hour, contemplating a dinner and a breakfast of dates and water, when a large truck appeared from out of the dunes behind us. With the two burly truck drivers to help it took only a couple of minutes to heave our Ford Corsair through the remaining sand, and with effusive thanks and much waving and honking we were on our way.

The rest of the journey proved relatively uneventful. A few hours later we were enjoying a good dinner in Keetmanshoop, the principal town in the southern portion of the Territory. The small hotels that we stayed at en route were a worthwhile experience in themselves. What they lacked in modern conveniences they made up for in hospitality and conviviality. At times we appeared to be the only guests, and frequently a menu was dispensed with altogether at meals. One simply ate what was put before one, often in amounts that would stagger the imagination. Breakfast, for example, was typically fruit, porridge, steak, sausage, bacon, eggs, potatoes, enormous slabs of toast and jam (the Afrikaner's 'konfyt'), and coffee. Dinner, bed and breakfast might together cost one \$4! The universal characteristic of these hotels seemed to be a well-equipped snooker room and an equally well-equipped bar, to which many of the local populace repaired for 'sundowners' and social chit-chat. They have about them a jolly and pleasant atmosphere, reminiscent of an English pub, and the Afrikaans conversation of sheep farming

and rural happenings flows as readily among the rough-and-ready farmers and their wives as does the good German beer.

From Keetmanshoop, to our surprise, a good paved highway stretched most of the remaining seven hundred miles to Grootfontein in the north. In fact, excellent highways are rapidly being built all along the north-south spine of South West Africa, and I have little doubt that in a very few years it will be possible to travel our entire route without having to leave paved roads. From the point of view of speed and efficiency that is to be welcomed, but I'm afraid that it will be a lot less exciting and interesting.

The following afternoon found us entering Windhoek, the capital, a city of about 43,000 people. It is the site of strong hot springs, which were once the source of the municipal water supply, and which led to the unusual circumstance of pouring oneself a glass of water and then having to wait for it to cool down before drinking it. Today it is a modern, sparkling city with a strong German flavour, and is most progressive. We soon found our way to the Zoo Garden, a small park, among whose attributes is perhaps the most casual collection of meteorites in the world. A couple of hundred miles south of Windhoek we had bypassed the small village of Gibeon shortly before crossing the Tropic of Capricorn. Somewhere east of Gibeon is said to be a valley strewn with meteorites, and some of these have been collected and carelessly thrown in a heap as a sort of rockery in the Zoo Gardens. There must be several dozen meteorites there, each of them with characteristic dimensions of a foot or so, weighing, I would guess, several hundred pounds each. There is no sign to tell the casual visitor what they are, and their sole protection in the open park is their own weight. (The Administration, however, is fully aware of the value of meteorites, and the removal of meteorites of any size is considered a very severe offence). Remarkable though they are, these meteorites evidently have no connection with the Hoba meteorite to the north, since they apparently have a different chemical composition.

On one of the hills surrounding Windhoek is an old fort, relic of the Herero wars and now a museum devoted largely to the history of the Territory in its colonial days. Among its exhibits, however, is a large photograph of the Hoba meteorite (there is an actual piece of it in another museum in Windhoek), with above it a plaque from the Smithsonian Astrophysical Observatory sent in 1965 as thanks for a piece of the meteorite "for purposes of scientific research". I was glad to have happened on this, because on my return to Canada I contacted Dr. Whipple of the Smithsonian and learnt some most interesting recent findings concerning the meteorite.

The following day we had our gas tank repaired and left on the final few hundred miles north to Grootfontein and the Hoba meteorite. The road runs through endless miles of savannah and stunted bush, for here one is among the great equatorial plains of Africa, and the rise over a small hillock often brings an unbroken 360° panorama of thornbush and dry, brown grass. Frequent signs caution the driver to 'Beware of Kudu'.



FIG. 3—The collection of meteorites in the Zoo Gardens of Windhoek.

The kudu is the largest of African antelope, comparable to a moose in size, which has a habit of ignoring cars until they are almost upon it, and then leaping desperately in any direction, including right onto the car itself. We ourselves didn't see any kudu along this road, but we often came on tremendous skid marks on the pavement which attested to those who had. In general, this part of the journey was pleasant and uneventful as we wound our way north through little villages with quaint-sounding names. At Okahandja we crossed the Swakop, largest river in South West Africa, but just a dustbowl when we were there. Further north we lunched at Otjiwarongo, a name meaning "the beautiful place". Finally, after another hundred miles or so over a rough dirt road, we arrived in Grootfontein, and by the late afternoon found ourselves looking down on the Hoba meteorite.

The Hoba Meteorite. The Hoba or Hoba West meteorite is named after the farm on which it lies. A small dirt road leads to it, beginning at the point where the road from Tsumeb enters Grootfontein, and ending at the meteorite itself, 13.8 miles away. However, development of a large



FIG. 4—The author atop the Hoba Meteorite.

new highway in the area is indicated on some maps, and it may be that access to the meteorite will be improved within a few years.

The meteorite is partly buried in the ground, and lies on a broad bush-studded plain near the foot of a range of low hills. These hills are not curved around the position of the meteorite at all, and it is clear that there is no surviving evidence of any crater associated with the object. In this it is similar to other large meteorites. Evidently they are sufficiently slowed by their passage through the atmosphere that impact with the ground is not as violent as one might think. Excavation has been carried out around one side of the meteorite so that one can gain some impression of the depth of the object and the underlying rock. It has been declared a national monument and a wire fence (partly broken down, however) surrounds it.

At first glance the most striking thing about the Hoba meteorite is its unusual shape. One is accustomed to thinking of meteorites as objects of irregular shape, often elongated, with severe ablation marks cutting into them. The Hoba meteorite presents a remarkably horizontal upper surface which is quite closely square. My measurements indicated the sides of the upper surface to be $3.05 \times 2.95 \times 3.00 \times 2.92$ metres, or very nearly 10 feet square. Ablation marks are present but not deep. The thickness of the object is difficult to gauge because of the incomplete excavation, but the average thickness is probably close to 1.0 metres, or a little over three feet. The general surrounding rock is limestone; that under the meteorite is severely shattered and is iron shale. A partly broken off tongue, about three feet long, is visible in the excavated portion and intrudes into the rock beneath.

The composition of the meteorite is now fairly well established, having been determined by a number of independent workers. It is described as nickel-rich ataxite, containing about 82 percent iron, 16 percent nickel, and small amounts of other elements, principally cobalt. Curiously, the official sign on the fence surrounding the meteorite incorrectly gives the composition as 93 percent iron and 7 percent nickel.

The composition indicates an average density close to 8.0 gm/cm^3 , and unless the under-surface is a large cone buried in the rock, the dimensions cited above indicate a volume of close to 9.0 cubic metres. The mass is therefore $7.2 \times 10^7 \text{ gm}$, or 79 tons, where a ton is taken to be 2000 lbs. Allowing for errors of measurement and the possibility of a greater extension of the meteorite into the rock, we might conclude that the minimum mass is of the order of 75 tons.

On my return to Canada I wrote to Dr. Fred Whipple of the Smithsonian Observatory to enquire what work had been carried out on their

recently acquired sample. I am greatly indebted to him for sending me a preprint of a note by R. McCorkell and J. D'Amico entitled "The Cosmic Ray Produced Radionuclides and the Terrestrial Age of the Hoba West Meteorite". These workers have concluded that this meteorite has been present on the surface of the earth for between 80,000 and 300,000 years, and that a layer approximately 27 inches thick was removed from the outer parts of the meteorite by ablation in passage through the earth's atmosphere.

Postscript. Our travels, of course, by no means ended at the Hoba meteorite. After a night at the Meteor Hotel in Grootfontein, we moved on north through Tsumeb to the big game country around the Etosha Pan, where we spent a couple of days hunting with camera and binoculars. We stayed a night in the romantic surroundings of an old German frontier fort, Namutoni, once the scene of a desperate siege and defence during the Herero Wars of long ago. Thereafter it was back south through Outjo and Otavi at high speed, with later a detour to see the Fish River Canyon. With our hearts in our mouths we retraced our route through the southern desert without mishap, and late in the evening of August 12, almost exactly seven days and 3200 miles since we had started, we arrived back in Cape Town. It was raining.

I suppose I would be hard pressed to find a good scientific reason ever to visit South West Africa again, but to those who know and love it, Africa is as compelling as the sea. Not to go back is unthinkable. There is a Bantu proverb which runs: "He who drinks of the waters of Africa must always return". I like to think that it is so.