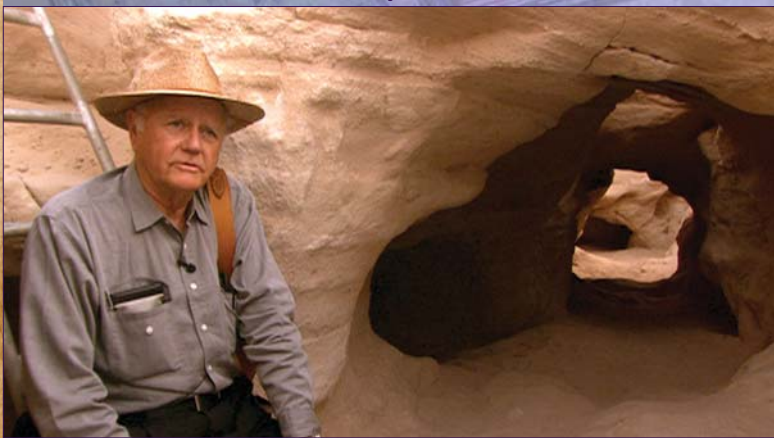


# METALLURGY



Wm. Revell Phillips.

**L**EARNING THE TRADE. Nephi seems to have a really strong background in metallurgical activities. The trade guilds in the ancient world were often very strong. Skills were taught by father to son, handed down—kept secret. He would have been trained very early. It is not uncommon for a child in a family like that, even in an upper class family, to be taught a trade. So there's something unique about his background. You've got the metal plates of Laban—the brass plates. It may be that this particular clan was connected with metalwork, that they kept their records on metal plates for that reason.

*Daniel Peterson*

There could be no doubt that Nephi appreciated fine metalwork. The first thing he noticed about the Liahona was its fine craftsmanship.

*John Welch*





The crew filming Revell Phillips by the iron ore outcropping at his left elbow.

Nephi needs to be shown by the Lord where to find ore, but he does not have to be told how to smelt it. How he learned this, we don't know. He was a younger son—the fourth son in the family of Lehi, and so he probably didn't have to work in the field or the olive orchards, as the older sons probably did. His father by that point had accumulated gold and silver. And it may have been that Nephi was able to study, learn, and work ore, maybe as his assignment within the family. This allowed him of course to make metal plates and to write on them. So a

major part of Nephi's background and personality seems to be that he understands the way in which metal is made and how it is used.

*John Welch*

Nephi specifically says that once they get to the New World, he instructs his people in the use of gold and silver, copper and iron (2 Nephi 5:15). So he has the knowledge somehow. The technology for both iron and bronze was well known in Jerusalem at Lehi's time. We are about 400 years into the Iron Age in Jerusalem.

Nephi makes two trips back and forth from Lehi's camp to Jerusalem, and we suspect that they were long trips. So that's five times that he passes through Wadi Araba, or near the Timna Valley. During long periods of time, the Timna Valley is where the metalworking was for Israelites one of the oldest mining areas in the world. They not only mined ore there but also processed it. Nephi may very well have stopped in that valley to learn from the metalsmiths there.

*Revell Phillips*

And if the family did have metallurgical connections, that might have dictated the direction they went. It would be a known route. If you do metalwork, then you probably know the mines of Timna at that period. So that may be a clue, at least a hint, for us to surmise which specific route they took.

*Daniel Peterson*



## IRON ORE

Nephi must have been a craftsman of some sort because he knew very well how to go about constructing a ship, although he did receive special instructions. But he knew he needed tools; he knew he needed ore to make the tools; he knew how to make the tools. We're aware that Nephi only asked the Lord one question. He didn't ask where to get wood; he didn't ask how to build the ship, he asked, "Where do I find ore, that I might smelt it to make tools?" (see 1 Nephi 17:9). There is actually very little iron ore anywhere along the southern coast of Oman. I doubt that there was an iron industry here at any time.

In looking at the geology of the area, we see that virtually the entire Dhofar, which is the big southern state of Oman, is covered by relatively recent limestone deposits—tertiary and Cretaceous limestones. Those are not intruded anywhere by igneous rock, and therefore they really have very little potential for having any kind of iron or ore in them, and indeed they do not.

Not only would Nephi have needed copper, he would have also needed tin to make bronze. But we have not found any copper at all anywhere in the southern part of the Dhofar and there's no tin on the Arabian Peninsula at all that I'm aware of. That fact would narrow Nephi's options down to iron, which is extremely abundant in the earth's crust. You can find it almost anywhere, except the Dhofar, which is limestone. Where the limestone has been stripped away by erosion, what we call basement

rock is revealed, which is high-grade metamorphic rock intruded by igneous granites. This, any geologist would know, is the logical place to find ore, and we did.

*Revell Phillips*

We arrived on the Southern coast of Oman, the Dhofar area, where none of us had ever been, so it was a lot like what Nephi faced in looking for ore—not knowing where to go and having to rely on, not just his expertise, but some help from the Spirit too. And that's the kind of attitude we had. We looked at the geologic maps and tried to pinpoint the most likely places for us to search.

We started in the western part of the Salalah plain, where Wadi Sayq is located. An old shepherd led us to a fishing village where we could get a boat because most of the coast is roadless and the only way to access it is by sea. At our first landing, we saw red and orange stripes cutting through the bedrock, and most of us knew exactly what that meant.

They were red and orange because there was iron in those seams that had rusted. We spent a few days documenting that and found one other site with iron. When we got back to Muscat and asked the Ministry of Mines of Oman about these occurrences, they confirmed that they were completely



Ron Harris.



Iron ore.

unknown to anyone. Swiss and Japanese geologists had made recent geologic maps of the area, but had found no iron. The Ministry of Mines, whose personnel really know more about the geology of Oman than anyone, confirmed that these were new discoveries, and that means that no one knew about them until the year 2000.

*Ron Harris*

What we find near Mirbat and Wadi Sayq is a very unusual geologic phenomenon where you actually have veins in the metamorphic rock, in which you have had cold intrusion—gases bringing up predominantly carbonates.

*Revell Phillips*

The unique thing about this deposit is that it has come from so deep, and it is very well exposed on the surface.

*Ron Harris*

But near the surface, that iron carbonate will break down or weather to form iron oxide, and iron oxide is the desirable ore.

*Revell Phillips*

What makes the find unique is the very soft pulverant limonite, which is iron with a little bit of

water in the structure, and also iron carbonate. This is remarkable, because by having those two things occur in the same rock, you have an iron ore that is much more easily smelted. I have never seen any iron ore like this any place in the world. This was the ideal mixture for a layman, you just have to go dig it up with your hands and it is ready to go. To me, the Lord did everything possible to make this easy to use.

*Jeffery Keith*

The unique part of the iron ore discovery that we made was that the iron is actually mixed in with carbonate, which is used naturally as a flux to lower the melting point of iron. The iron ore is highly concentrated, and so not only would it have been easy for Nephi to see and collect, it would have been easy for him to make a tool from these raw materials.

*Ron Harris*

The iron ore in only these two areas is right on the surface of the ground. We have veins of iron ore coming up through the metamorphic rock right to the surface of the ground. And so collecting it would have been no problem at all.

Nephi could have collected enough iron ore in a matter of a few minutes to make all the tools he would want. And it is right by the coast, you load it into a small boat, carry it wherever you want it, and process it.

*Revell Phillips*



Jeffrey D. Keith.



## TOOLMAKING

The technology for processing iron was also very well known in Lehi's time. However, processing iron is much more difficult than processing bronze. Bronze can be melted at a temperature of 1200 degrees Celsius, whereas iron requires 1500 degrees. And the normal pit or bowl furnaces could not reach that temperature.

Nephi would have constructed a bowl or a pit furnace, which consists of nothing more really than a circular hole in the ground. And what one does is load the bottom of it with charcoal. When the charcoal is glowing red, you put layers of crushed iron ore—iron oxide—on top and then you put charcoal. And then you cover it with clay or some such thing, and finally blow air into the bottom. (Nephi speaks of making bellows out of the skins of animals; see 1 Nephi 17:11.)

The oxygen in the forced air rises through the charcoal and combines with the carbon to form carbon monoxide. The carbon monoxide rises through the crushed iron ore and charcoal, takes the oxygen away from the iron which leaves metallic iron. It is not molten but metallic iron; it has little crystals. The gang minerals—that is the silicates that accompany the iron—will melt at the attainable temperatures and form a slag. The iron occurs in a mass we call bloom, which consists of an aggregate of tiny iron crystals, usually very spongy, full of vacant spaces. It collects on top of the slag. You reach in and you take out that mass of bloom.

*Metallurgy*

You can logically ask how Nephi would retrieve the bloom from the furnace. It would be nice to have some tongs to reach in and pull it out. It can be done, however, simply with green sticks. Perhaps Nephi did not have an anvil to put it on. He could have put it on a rock and pounded it with another rock, but I would be very surprised if Lehi had not brought with him at least a hammer. He prepared for the journey and he almost certainly brought along some kinds of tools, at least a hammer, an ax or adze, or something to dig holes with.

Nephi would have pounded the bloom, reheated it, pounded it again, and repeated this process until he got it into the shape he wanted. And then of course, if he wanted an edge on a chisel or something, he could have ground one on sandstone or another rock.

It took a real craftsman to know how hot the furnace had to be, how long you needed to leave the iron in the furnace, how thin you needed to pound it—so many variables. And a real craftsman would have known how to do that, and would have been of infinite value to his people. The blacksmiths at Damascus figured out how to do that, and we frequently refer to Damascus steel as being a very fine grade of steel.



Nephi hammers a tool into shape.



*Revell Phillips*





Above: The sword of Laban.

Below: Grip of a composite bow.



## THE SWORD OF LABAN

It may have taken months or even years to create a very fine sword. In antiquity, these very fine quality swords took on almost a human personality. They were highly revered and passed on from one generation to another. King Arthur's Excalibur, for example, was such a legendary sword.

The sword of Laban appears to have a story similar to that, and it was certainly revered by the Nephite people. That kind of a sword was unusual anywhere. Only very important people had them, because it required great craftsmanship, long periods of time to make, and very extensive work.

In Jerusalem, at the time of Lehi, we appear to have had a group of people who, in my opinion, escaped out of the northern kingdom at the time Assyria conquered it, which would have been 100 years before. So we have refugees or expatriates in the city of Jerusalem. Lehi, Ishmael, and Laban were part of these expatriates. Laban appears to have been the leader of the expatriate group. He must have been the leader because he had the scriptures and the sword.

*Revell Phillips*

## NEPHI'S STEEL BOW

In the ancient Near East several types of bows were in use. There was one formed of a single stave of



wood shaped into the form you want; the bow is shot simply by pulling the wood back. Composite bows are made up of horn, sinews, and wood, all glued together and molded into a specific shape. These bows could be reinforced by metal on the handles and on the tips where there was the greatest pressure. As a bow is bent there is pressure along different parts of the bow. This reinforced composite steel bow was designed specifically for shooting arrows to penetrate armor. So it needed to be stronger and more powerful. They were really weapons of war rather than hunting and therefore would have been relatively rare and used by the elite in society, not by ordinary people.

*William Hamblin*



Nephi's bow had metal as a part of it. It may have been a composite bow, reinforced with metal straps. And the stress may have also weakened the bow in some respects because the metal straps would have ended at certain points and maybe that's where the pressure points against the wood would have contributed to the bow breaking (1 Nephi 16:18).

*John Welch*

Some of the Mongol tribes that invaded the West from central Asia brought with them little short bows which had a wooden element, an element of sinew, and an element of steel. Steel has spring to it. Nephi was very proud of his steel bow and did very well with it apparently.

*Revell Phillips*

The weakening of Nephi's bow would have been compounded by changing ecology. Composite bows were glued together and bound in certain ways. And as the amount of moisture in the air and the temperature changed that would cause expansion and contraction and eventually weaknesses. So one assumes that the Nephi's steel bow is this type of metal-reinforced composite bow, rather than a bow that was 100 percent metal. Nephi's bow would have broken along the major stress points.

*William Hamblin*

## GOLD PLATES

Almost certainly the gold in the plates was panned. Where Lehi's family landed in the New World is not exactly known, but the scripture does speak of abundant ore near where they landed.

Gold melts at a much lower temperature than iron. And so the simple pit furnace has the capability of melting gold. If you melt the gold and simply pour it out on the surface of a rock, and then pound it, you can achieve a remarkably thin sheet. With a knife, you could simply cut square pages out of that gold and then take the gold that was left over, melt it down, and make another page. I envision the gold plates as being very thin sheets, which undoubtedly would be inscribed on only one side, probably with a stylus of some sort.

But it is not a simple task to make gold plates. Gold is hard to come by. It undoubtedly wasn't as hard to come by in Nephi's day as it is today, because most gold areas have been mined out, but it would still have been very difficult to mine. And the various writers of the Book of Mormon in many places express that they wish they could write more, but they did not have room on the plates they had (Jarom 1:2; Omni 1:30; Ether 12:25).

*Revell Phillips*

