The Official Newsletter of The Principality of the Summits

The Echoes

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October, AS LIX (2024)

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ARTS AND SCIENCES OF THE SUMMITS POPULACE!

"Pentatonic Mug" handcrafted by HL Alan Bowyer of Adiantum. Can you figure out why he calls it that? :-) (Hint: texture, color and music)

Greetings from your Summits Chronicler

Hello, Summits! As always, I welcome your ideas, feedback, and SUBMISSIONS - let's fill these issues with your art, articles, photos, and anything else SCA-related that you'd like to share with the Principality! I'd love to spotlight YOUR talent. Please send submissions to summitschronicler@antir.org.

In Service,

Lady Elizabeth Chandler

Their Alpine Highnesses

Prince Amalric and Tlatocapilli Z

A fine hello to the populace of the great Principality of the Summits!

The fall equinox has come and gone and with our retirement on the horizon, we are wistful for the lovely moments we've been lucky enough to share with you all. From late night bardics, to much-deserved awards and Peerages, to betrothals of love, and support for other royals as they pass through these generous lands. We've been most fortunate to receive visits from both Our Crown and Their Heirs during our time. These past months have been filled with such delight for your Princes.

After a heartwarming Coronet Finals, We are excited to have fabulous Heirs! Ivan and Mina will no doubt guide us through the cold half of the year, their joy as a bulwark against the chill.

Looking forward to our remaining events, we are still hoping to receive more award recommendations. Even if we are not able to get bestow them Ourselves, we will be sure to pass everything on to Our Heirs. Amergins in Adiantum was wonderful, Samhain in Glyn Dwfn is lookingto be just as lovely, and Apple & Song in Terra Pomaria will wrap up our reign, culminating in what looks to be a beautiful 11th Night Investiture back in Adiantum.

For now, let us all enjoy the light and warmth of friends, family, and togetherness.

In Service to The Dream, the Crown of An Tir, and the populace of the Summits,

Tlatocapilli Z
Prince Amalric

Photo credit: Ylva Annarsdottir

Request For Proposal: Summits Travel Thrones

Unto The Artisans Of The Summits:

Do I Sir Weylyn ibn Rustam, Summits Chamberlain, send greetings. I am posting a Request for Proposal for new thrones to replace the current Coronet "travel" thrones, which are unsafe and at the end of their life. Our thrones have served the principality well; however, they are at a point in their life where they are beyond repair. With the approval of Their Highnesses Amalric and Z and the Principality of Summits Financial Committee, we are hereby publishing this Request for Proposal to obtain bids from artisans to create a set of new thrones for The Coronets and Principality of the Summits.

Design:

* The new thrones MUST be sized to accommodate individuals of various sizes and shapes. Multiple or interchangeable pieces will be acceptable.

* The new thrones MUST be easy and intuitive to set up and take down.

* The new thrones MUST break down to be easily transported.

* The new thrones MUST be light enough for a single person to carry.

* The new thrones MUST be manageable and require no more than two (2) people to set up in less than five minutes(ish) per throne.

* The new thrones MUST be durable with the expectation of 15+ years of service.

* The new thrones MUST primarily be made of wood (other non-wood elements MAY be added)

* The new thrones SHOULD represent the grandeur of the Summits, and when displayed among other thrones of the Kingdom, be recognizable as the Principality of the Summits through color, iconography, shape, etc.

* There SHOULD be some level historical authenticity in design; however, a fully authentic design may not be feasible based on prior requirements for transport, set up/take down, and cost and time.

*The new thrones SHOULD each be able to be transported comfortably in most automobiles, including compact cars.

(continued on next page)

* It is encouraged that bids include the utilization of multiple artisans. Examples include woodworking, painting, sewing cushions and pillows, etc.

* It is recommended that research is conducted into other currently used travel thrones throughout the Knowne World to establish a design baseline.

* It is recommended that travel bags to protect the thrones be included in the bid, however it will not disqualify your bid if it is not included.

* The new thrones MAY utilize components of former thrones incorporated into the design and construction for nostalgic purposes.

Timeline:

* Bids are due to the Principality Chamberlain by 11th Night, 2024.

* Email bids to SummitsChamberlain@antir.org

* The bid MUST contain a timeline for delivery as well as timeline benchmarks to send the Summits Chamberlain status updates with pictures.

Bids:

* Bids will be evaluated for completeness and should include costs, design, material details, timelines, and final delivery date.

* Bids that also include designs for repurposing of the old "travel" thrones will be considered.

For any questions, please contact me via email at SummitsChamberlain@antir.org or Weylyn ibn Rustam on Facebook.

I remain in service to Principality and Kingdom,

Sir Weylyn ibn Rustam, Summits Principality Chamberlain

Notes: At this time, we are only accepting bids for the "travel" thrones. A separate Request for Proposal will be published at a later date to replace the "box" thrones, which are also nearing the end of their useful life.

Spilling The Tea With The Tanists

By Viscomt Antoine a la Langue d'Or

Hello readers,

Once again I have had the incredible pleasure to sit down and interview their Royal Excellencies Ivan and Mina and in doing so, was able to get a sense of what their states of mind were going into this coronet, and possibly more relevant to our readers: what the upcoming reign is going to be like!

Anyone who was there will tell you Ivan had a strong day on the field, but for many of us, Sir Ivan looked like a man possessed. When asked how did this coronet victory feel different? He said:

"The big thing is Inspiration! Yeah sure I did the work, all the training and preparation sure, But without Mina none of this is happening. Inspiration is the key to victory, in my humble opinion. It determines the outcome as much or more than skill."

When asked "Why this September, and not last or next March?", her Royal Excellency had this to say:

"Our goal was a winter reign. We have already had what I hope was considered a successful summer reign. We wanted to support the Principality in the other seasons. Events that focus more on the Arts and Sciences and Bardic community. It gives us a chance to do something different and see it from the other side of the coin. Besides, not everyone who plays in summer also plays in winter. We want to support them too."

Once again, their Excellencies are actively choosing to not have one particular theme for the reign, to focus mainly on building up the principality and celebrating the Summits and its people. That being said... it doesn't mean they aren't planning on some fun.

This coming reign promises to be filled with lowkey but definitive Shenanigans. For instanc: training in a practice in Reno recently, Duke Kenric got wrapped good and solidly upon his... well lets say that sitting wasn't the most comfortable activity for the next little while. Their most Royal Excellencies paid out a bounty of Oreos to the skilled fighter (Teagan Ulfsdotter) for their positively precious posteriorously placed POP.

So everyone from our emerald dales to our darkest glens; from our foothill habitats to coastal cliff communities; on every mountainside manor; in every high desert holdfast - be on the lookout for opportunities for some practical comedy to present itself. Their Excellencies are looking to pay out a series of sweet bounties.

What primary time period are you thinking of dressing as, to lead the Summits fashion scene? "We have been kicking around doing late period. We have been more than toying around with Landsknecht and late Period Polish. The best part of a winter reign is the award shows. You get to look good and feel good with the people.

So all of you people trying to stay in the latest of fashion; bust out your slash and poof, and shake those booty shorts, 'cause we are going to Germany in its most fabulous of time periods.

So who will they be wearing ?
The Garb team will be led by Lucas Brandenburg & Baroness Ainslee.
They will be assisted by Taran Destinger, Mikkel Hoie, Christmas Caryl, & Baroness Morghan and of course her excellency Liesl. With names and talents like those, we know we are in for some high fashion a court this coming winter.

When asked "what lessons will you bring from your first reign into your second that you may serve your people even better than before?", this is what his Royal Excellency had to say:

"The big one is to make sure I am properly attended. I was used to doing things on my own, but I came to realize I was denying others the opportunity to shine in the service. I don't want to make the same mistake. The other thing is being ok with your decision-making. I want to be confident and not fret about the decisions you have to make while wearing the coronet. Remembering that we can't please everyone, but I know deep in my heart we are always doing our best."

And of course for the answer to the question that burns in the heart of the entire Summits army...Yes! The Gryphon banner will be raised at Gulf Wars, and His Royal Excellency Will be Joining His Royal Highness An Tir upon those fields of glory. So make your plans and book your flights - Summits is going to Gulf Wars.

As we were wrapping up the interview, her Royal Excellency had this jewel of wisdom to share with all of you:

"We have been marching forward into the future on a positive note. As long as we keep the dream in our hearts, and remember we are all one people building the dream together, as long as we do that - we can't do anything but succeed."

Youth of the Summits Participate in Siege Cooking Challenge

Submitted by Lady Adele Neuton, October 2024

Several youth from the Barony of Terra Pomaria participated in the Youth Siege Cooking challenge at Autumn War / Emprise of the Black Lion on September 13th, 2024, and were part of the winning team.

Team Sam & Friends. Bottom left to right: Lillian (4), Elizabeth (17), Sam (9), Celina (14), Kira (7)

Elizabeth Neuton and three of her sisters, Celina, Kira, and Lillian, joined up with Sam of the Barony of Madrone, to form Team Sam & Friends. They ranged in age from Elizabeth, age 17, to Lillian, age 4.

The theme was Levantine, in honor of Blatha an Oir's Baron, Nels Ulger I Jaren. Teams were provided an assortment of ingredients, including whole quail, saffron, dates, couscous, garbanzo beans, almonds, raisins, lemon, apples, carrots, onions, and figs. They were allowed to bring their own cheese, butter, olive oil, vinegar, garlic, spices, sugar/honey, and eggs.

Chef Sam, who is 9, led the team to victory with a delightful meal of pan-fried quail and vegetables, lemon couscous with raisins and apricots, dates stuffed with goat cheese, and a lovely pitcher of the ancient Persian drink, Sekanjabin.

They competed against one other team, and the competition was extremely close. But in the end, the judges chose team Sam & Friends, due to the extraordinary perfection of the quail, and the fact that the lead chef, Sam, who is only 9 years of age, was able to easily pronounce the names of the dishes, and even the names of all the ingredients and spices!

The Scribes Of Adiantum bring you:

The 2025 (AS LIX-LX) CALENDAR

$20 each

Preorder Now Thy Copy!

It Maketh Surely A Delightful Yuletide Gift!

Preorder Deadline November 21.

8.5x11" (11x17" open) 2025 (AS LIX-LX) Calendars are available for preorder. $20 per copy. We have 9 contributing scribal artists, all from Adiantum, ages 10 to many times 10, first year scribes to lifelong artists. Our goal was to create a calendar to celebrate the diverse talent of our barony, get beautiful, medieval style art to the populace, and support our barony. Preorders made by November 21 can be delivered at 11th Night. Payment may be made upon pickup by either cash or check made out to the Barony of Adiantum. Please send preorder requests along with contact info to Muirenn (Katie Kelm of Facebook or growwildmychild@gmail.com) Payment in cash or check (made out to: SCA Inc, Barony of Adiantum) due upon pick up.

January

April

June

The Alpine Codex

Autumn Edition

From the Staff

Here at The Codex, we are excited to release our first publication of submitted work. The research papers featured in this issue are the first round to be submitted to, reviewed, and selected by our full panel of peers. Though we are still finding our stride and refining the process, we are overjoyed to present these wonderful papers to you.

About the Author

Eiríkr Skreyja went to his first event at An Tir West War in 1994 during high school and fell in love. He has played in An Tir, West and a small amount in Caid. Squired to Earl Daffyd A Gwynedd who is no longer playing and lives in Japan. His awards and achievements include an Award of Arms and a Swan for having been to the finals of two Cynaguan Coronets.

About the Author

Hrodnavar Hakonsson, Order of the Pelican, Order of the Laurel moved from Caid to An Tir (Adiantum) just before the Great Plague. Now that things are up and running again, he has to figure out how to do SCA in the rain.

THE ALPINE CODEX

is a quarterly arts and sciences journal wherein research and process papers are published.

HOW DOES IT WORK, AND CAN I SUBMIT?

Absolutely! Anyone can submit their paper for review. To Submit just send an email to Summitschronicler@antir.org with the words "Codex submission" and (Authors Name)" subject line. Please send all papers in the pdf if formatted with pictures or docx if just text.

DO I HAVE TO LIVE IN THE SUMMITS TO SUBMIT A PAPER?

Not at all! The goal is to publish between 1-3 papers in each issue; one of the "slots" to be designated for a featured Summits Scholar.

The Alpine Codex Peer Review Panel

Viscomt Antoine a la Langue d'Or (Administrator)

Baroness Yseult of Broceliande Companion of the Laurel and Pelican

Vicaria Vesta Antonia Aurelia Companion of the Laurel

Viscount Seamus O'Caellaigh Companion of the Laurel and Pelican

Viscountess Temperance Trewelove Companion of the Laurel and Pelican

Armor and Weapons of the Chinookan People

By Eirik Thorsgard aka Eiríkr skreyja in the Society of Creative Anachronisms

The Chinookan people inhabit the area in the Pacific Northwest of the Unites States that borders Oregon and Washington states. They lived along the edges of the Columbia River from the mouth up to an area today known as The Dalles, but was formerly the Celilo Falls area[1]. I am a descendant of these people and specifically from the Willamette Falls and the area around the Cascades, I am enrolled with the Confederated Tribes of the Grand Ronde Community of Oregon a federally recognized Tribe and have family enrolled at several tribes across the greater Pacific Northwest. I am writing this short article to provide some basic information about the Columbia River people and specifically their armor and weapons and how I am incorporating them into my participation in the Society for Creative Anachronisms. With this in mind, I hope that the following information will help some of my friends and soon to be ones get a better understanding for my armor.

The earliest recorded contacts between indigenous people in the area and the first explorers that came to the greater pacific northwest mention armor in the Puget Sound near present day Hood Canal, WA and was recorded by third in command of the Discovery (Vancouver's flagship) Lieutenant Peter Puget:

> "The Men had a War Garment on, it consisted of a very thick Hide sup made from the Moose Deer, well prepared. I have no doubt but it is a Sufficient Shield against Arrows, though not against Fire Arms The Garment reaches from the Shoulders, down to the Knees, this however was got in exchange for a Small piece of Copper"[2],

Later Gabriel Franchere in September of 1810 while onboard the Tonquin a ship that was part of the John Jacob Astor and the founding of Astoria. He notes of the armor:

> "Their combats are almost all maritime: for they fight ordinarily in their pirogues, which they take care to careen, so as to present the broadside to the enemy, and half lying down, avoid the greater part of the arrows let fly at them. -But the chief reason of the bloodlessness of their combats is the inefficiency of their offensive weapons, and the excellence of their defensive armor. Their offensive arms 'are merely a bow and arrow, and a kind of double-edged sabre, about two and a half feet long, and six inches wide in the blade: they rarely come to sufficiently close quarters to make use of the last. For defensive armor they wear a cassock or tunic of elk-skin double, descending to the ankles, with holes for the arms. It is impenetrable by their arrows, which cannot pierce two thicknesses of leather; and as their heads are almost covered with a sort of helmet, the neck is almost the only part in which they can be wounded. They have another kind of corslet, made like the corsets of our ladies, of splinters of hard wood interlaced with nettle twine. The warrior who wears this cuirass does not use the tunic of elk-skin; he is

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[1] For additional information on Chinookan people see: Handbook of North American Indians Vol. 7. Smithsonian Institute Washington. 1990.

[2] Readings in the Pacific Northwest History – Washington 1790-1895 edited by Charles Marvin Gates Published by University Bookstore Seattle, WA 1941 pg. 27

consequently less protected, but a great deal more free; the said tunic being very heavy and very stiff"[3].

Jon Dunn a member of the Hudson's Bay Company that served at Fort Vancouver as well as at Fort George at the mouth of the Columbia River noted in his own recollections about the armor the armor of the Chinookan as:

"According to the general custom of American savages, when employed in warlike expeditions, they painted their bodies and faces in the most grotesque and hideous manner. Their arms were bows and arrows; spears; and war clubs two and half feet long, and double-edged. Some wore a corslet formed of pieces of hard wood, laced together with bear-grass, so as to form a light coat of mail, pliant to the body; and light casque of cedar bark, leather, or bear grass sufficient to protect the head from and arrow or a war-club. A more complete article of defensive armour was a buff jerkin or shirt, off great thickness, made of doublings of elk skin, and reaching to the feet; holes being left for the head and arms. This was perfectly arrow-proof; and was, besides, often believed to be endowed with charmed virtues, imparted by the priests or conjurors of the tribe"[4].

A member of the Pacific Fur Company Ross Cox was stationed in Fort Astoria in 1812 and later worked for the North West Company which bought out the Pacific Fur Company in 1813. He notes:

"The Indians so far had been always friendly, and were in the habit of occasionally trading at Astoria; but as the tribe who resides at the rapids had the previously manifested hostile feelings, it was deemed necessary to prepare for action. Each man was provided with a musket, and forty round of ball cartridge, with pouch, belts, &c.; and over this clothes he wore a leathern armour: this was a kind of shirt made out of the skin of the elk, which reached from the neck to the knees. It was perfectly arrow-proof; and at eighty or ninety yards impenetrable by a musket bullet. Besides the muskets, numbers had daggers, short swords, and pistols; and when armed *cap-a-pie*, we presented a formidable appearance.[5]"

and

"Their warlike weapons are the bow and arrow, with a curious kind of short double-edged sword or club, two and half feet in length by six inches in breadth. They seldom, however, fight near enough to make use of this formidable instrument. Their armour consists of a shirt of elk-skin remarkable thick, doubled, and thrown over the shoulders, with holes for the arms. It descends to the ankles; and from the thickness of

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[3] Gabriel Franchere Portrays the Customs of the Columbia River Natives *IN* Readings in the Pacific Northwest History – Washington 1790-1895 edited by Charles Marvin Gates Published by University Bookstore Seattle, WA 1941 pg. 33.

[4] The Oregon Territory and The British North American Fur Trade by John Dunn Published G.B. Siever and Co. Philadelphia 1845 page 89-90

[5] Adventures on the Columbia River, etc. Vol. 1. 1831 By Ross Cox. Published Henry and Colburn and Richard Bentley, New York. Page 123.

the leather is perfectly arrow-proof. The head is covered by a species of helmet made of cedar bark, bear grass and leather, and is impenetrable to arrows. The neck, therefore, is the only vital part of the body exposed to danger in action. In addition to the above they have another kind of armour, which they occasionally wear in place of the leathern shirt. It is a species of corset, formed of thin slips of hard wood ingeniously laced together by bear grass, and is much lighter and more pliable than the former; but it does not cover so much of the body[6]".

Another contemporary during this time period Alexander Ross served on the Pacific Fur Trade Company and relates in his own recollections that:

> "Their war garments are of two kinds, one is termed cemal, of elk-skin, dressed and worked to the thickness of nearly half an inch, and arrow-proof. The clemal nearly covers the whole body, with an opening left on the right side to allow the arm free action in combat. The other kind of vest, made of small round sticks of the size and shape of arrows, twelve inches long: they are laid side to side, and then sewed together, and fixed on the body like a waist-coat. This is arrow-proof also. They carry a circular shield about eighteen inches in diameter, which is likewise made of the elk-skin; but in addition to its thickness it is hardened by fire and painted, and is not only arrow-proof, but proof against the knife and tomahawk also. Their implements of warfare are guns, bow and arrows, knife, bludgeon, and tomahawk, and all of which they use with great dexterity. A Chinooke Indian armed *cap-a-pie* is a most unsightly and hideous being.[7]"

The reported resistance to musket fire is also repeated in other accounts such as "In 1792, Lt. William R. Broughton was sent by Captain George Vancouver on a launch to explore the newly discovered Columbia River. On October 28th, Broughton passed a Chinookan village which archaeologists and ethno-historians believe was Cathlapotle (Ames et al. 1999:14; Boyd 2011:8-10). There canoes full of Chinookans rowed out to the *Chatham*, and small trinkets were exchanged and traded. Broughton then demonstrated his rifle to the startled Chinookans by shooting their clamon armor (Bell 1932:143-144; Vancouver 1984:755-757; Manby 1992: 199,323; Boyd 2011:10-13)." Some thirty years later George Simpson who wrote in 1824-25 indicates that: "…on their War excursions however they Wear a double Shirt of kind of Guernsey frock of thick Deer Skin two fold which is arrow proof.[8]".

In addition to the early historical narratives of Chinookan armor and weapons there exists ethnographic analysis of many communities that includes descriptions of these items. One of the most upland band of the Chinookan groups known as the Wasco lived near present day The Dalles, Oregon. Anthropologists Leslie Spier and Edward Sapir describes there armor as:

> "Armament for war consisted of bow and arrow, shield, and lance. Arrows were provided with stone heads dipped in rattlesnake poison. Dr. W.D. Strong was told that ants were also used to poison arrows. Others had segmented points which snapped off, remaining in the wound. A round hand shield was used (material unknown, painted red

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[6] Adventures on the Columbia River, etc. Vol. 1. 1831 By Ross Cox. Published Henry and Colburn and Richard Bentley, New York. Page 323-324.

[7] Adventures of the First Settlers on the Oregon or Columbia River. 1849 By Alexander Ross. London. Pages 89-90.

[8] In Fur Trade and Empire George Simpson's Journal 1824-1825 edited by Frederick Merk Harvard University Press 1931. Page 97.

and blue. The informant did not know whether stick armor was used. The lance was not made by the Wishram but obtained from the Wasco, who took them from the Paiute[9] in battle. The last were admitted to be very skillful in throwing them. We may suspect however that these were not missiles but short stabbing lances as elsewhere in the west. Such lances had hardwood shafts and flint heads. McGuff sketched a triangular blade, three and a quarter inches long, presumably found on the old Wishram village site, as one of these.'" War paint was usually red, sometimes yellow. This aligns the Wishram with the Basin tribes. On the other hand the Klamath and Takelma used white.'" A feather headdress was worn in war. This seems to have been: the circular crown of the Idaho-Montana tribes, not the full headdress of the Plains. The feathers were sewn on a buckskin band of two inch width with sinew or buckskin thongs. These were usually uniform in length, although some men mixed long and short feathers. Headdresses of tail feathers were quite highly valued. Eagle feathers were more commonly chosen by chiefs and principal warriors, others using those of various large birds. Such headdresses were also worn at important meetings. , Presumably the Wishram went to war fully clad, for Simpson remarks repeatedly on the nakedness of the Paiute in the account cited above[10]".

Ethnographic information complied by Verne Ray for the Chinookan bands at the mouth of the Columbia River displayed some differences.

> "The warriors, together with the shamans, took part in the dance. The former were attired in full war regalia, including armor, helmet, and face paint, and carried pecten shell rattles and weapons…[11]"

Later he describes the armor more fully:

> "A full outfit of armor was worn by the Chinook warrior. A heavy stiff vestment of double thickness of elk skin covered the body down to the ankles; arm holes were provided, leaving the arms free. This was quite impenetrable to arrows. On the head was worn a helmet of elk skin or perhaps heavy basketry work in cedar bark or bear-grass. Instead of the cumbersome elk skin garment a light armor or wooden rods, twined with nettle cord, was sometimes worn. The rods were short so that the covering amounted to scarcely more than a narrow jacket but its wearer was left quite free for action. In addition, a circular shield about eighteen inches in diameter was carried. The heavy, painted elk skin of which it was constructed was rendered even more impenetrable by hardening with heat.
>
> Weapons consisted primarily of bows and arrows and clubs. The latter were fashioned with considerable care as shown in an illustration by Lewis and Clark. Here a knot served as a knob on the handle end. Bone clubs were in considerable use; pestle shaped stone clubs were known; and also, according to Mrs. Luscier, those with round stone clubs were loosely fastened to a wooden handle by a covering of buckskin.

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[9] Paiute are an interior tribal community that primarily inhabit the Great Basin Region of the western US.
[10] In Wishram Ethnography by Leslie Spier and Edward Sapir. University of Washington Publications in Anthropology Vol. 3, No 3. Pp 151-300, May 1930.
[11] In Lower Chinook Ethnographic Notes by Verne Ray. University of Washington Publications in Anthropology Vol. 7, No. 2, pp 29-165, May 1938.

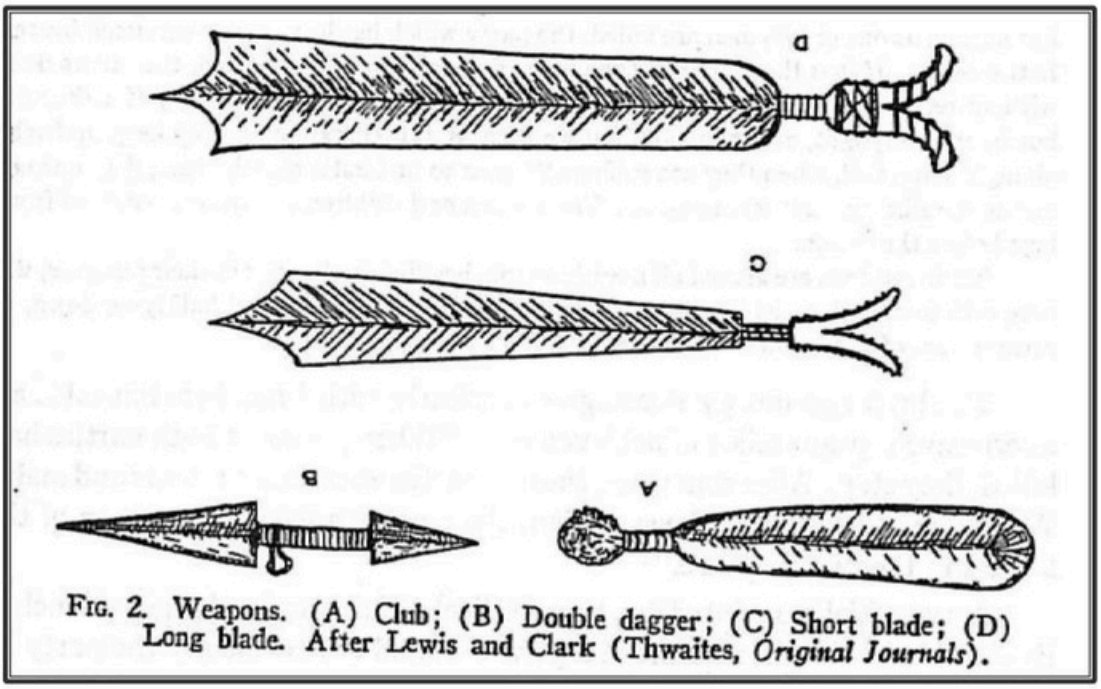


FIG. 2. Weapons. (A) Club; (B) Double dagger; (C) Short blade; (D) Long blade. After Lewis and Clark (Thwaites, *Original Journals*).

The double-pointed dagger with medial handle, widespread on the Northwest Coast, was used extensively by the Chinook. These were formerly of bone, though the pattern was later copied in iron. A rough sketch by Lewis and Clark show the asymmetry in blade length. The shorter blade was four to five inches long, the other about twice that length. The handle, which was wrapped with cord and provided with a thumb loop, was of proper size to fit the hand. These daggers were carried quite constantly and used for a multitude of purposes.

Double-edged weapons, sometimes as much as four feet long, are referred to by several writers by terms such as sword, sabre, and club. The last name suggests that these were of wood, but their actual nature and origin is altogether uncertain Those illustrated by Lewis and Clark are described only in terms of size, three to four feet in length, four and on-half inches in width. The dimensions Franchere as two and one-half fee by six inches; he adds that they rarely came into sufficient close combat to use these.

Thompson describes canoes with over-decking extending ten feet from the prow on which two warriors with spears stood in battle.

Warriors painted their faces, their bodies where exposed, their shields and their armor. Franchere writes of "most extravagant designs" but describes only the half black, half white face painting of one war chief. Scouler mentions paints of black, red and yellow. Broughton states that, "The [Chinook] natives differed in nothing materially from those we had visited during the summer [Nutka], but in the decoration of their

persons; in this respect they surpassed all the other tribes with paints of different colors, feathers and ornaments[12]".

Unfortunately while there is a rich description of the armor examples are limited. One extent example of a clamons or elk hide armor known to originate from the Columbia River is analyzed by Chinook Tribal Artist Tony Johnson[13]. While the article focuses primarily on the artistic representation it did include an image which has been later used to fully attempt to analyze what it may have looked like.

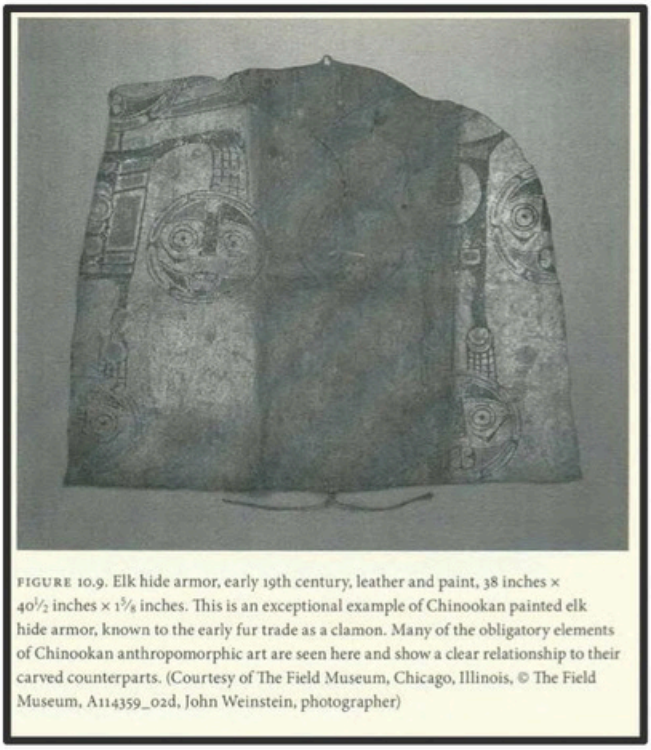
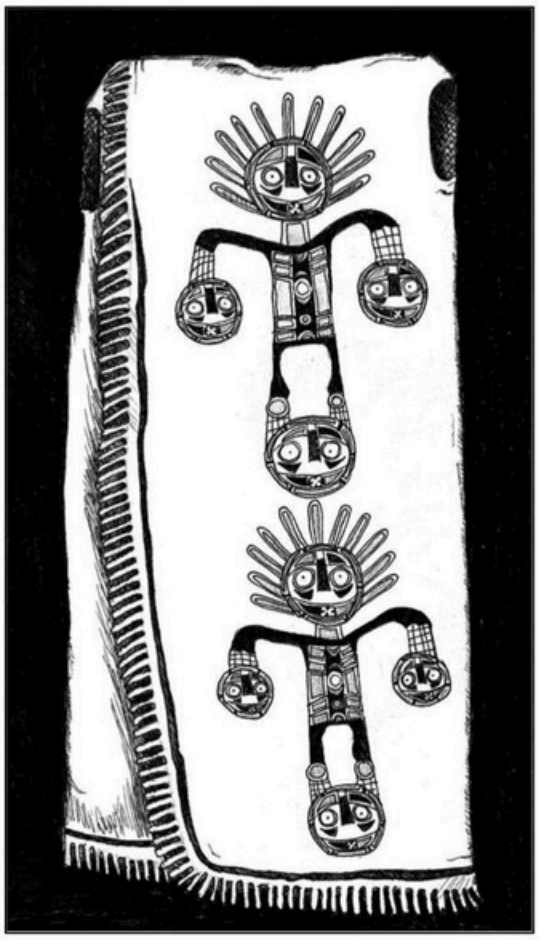


FIGURE 10.9. Elk hide armor, early 19th century, leather and paint, 38 inches × 40½ inches × 1⅝ inches. This is an exceptional example of Chinookan painted elk hide armor, known to the early fur trade as a clamon. Many of the obligatory elements of Chinookan anthropomorphic art are seen here and show a clear relationship to their carved counterparts. (Courtesy of The Field Museum, Chicago, Illinois, © The Field Museum, A114359_02d, John Weinstein, photographer)



The image on the right is an artistic reconstruction by archaeologist Stephanie Catherine Simmons[14], the focus of her work was primarily focused on the use of lithic technology it does explain the trade network associated with clamons and places them into a larger regional context:

"Sea otters were not particularly plentiful in the region around the mouth of the Columbia. However, there was a great demand for clamons (Figure 3), elk hide armor,

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[12] In Lower Chinook Ethnographic Notes by Verne Ray. University of Washington Publications in Anthropology Vol. 7, No. 2, pp 29-165, May 1938

[13] Lower Columbia River Art by Tony A. Johnson, Adam McIsaac, Kenneth M. Ames and Robert T. Boyd in Chinookan Peoples of the Lower Columbia River, [ages 199-225. University of Washington Press (June 2013).

[14] In Exploring Colonization and Ethnogensis through and Analysis of the Flaked Glass Tools of the Lower Columbia Chinookans and Fur Traders submitted by Stephanie Catherine Simmons as thesis for Masters of Science in 2014

which were produced in the lower Columbia and the Willamette Valley (Ross 1849: 89; Elliott 1927:278-279; Ruby and Brown 1976: 59-72; Gibson 1992:9, 230-231; Boyd 2011:12, 14). As a result, the Columbia soon became an important part of the larger trade network. Now fur traders exchanged trade goods with the Chinookans for clamons, and these clamons were traded to northern groups, such as the Nootka and Tlingit (located in modern day British Columbia) and Haida (located in modern day British Columbia into Southeast Alaska), for otter pelts. The Chinookan people took these trade goods and exchanged them for resources with inland and upriver groups (Gibson 1992: 8-10, 230-231; Mallory 1998:31; Boyd 2011:14-15)[15]".

The later Dr. Jon Daehnke did with the Cathlapotle educational material available at Ridgefield National Wildlife Refuge in Ridgefield Washington, where this same clamons is used in seeing and interpreting the Cathlapotle site.

[15] Exploring Colonization and Ethnogenesis through an Analysis of the Flaked Glass Tools of the Lower Columbia Chinookans and Fur Traders by Stephanie Catherine Simmons Thesis submitted for MS in Anthropology, Portland State University 2014, Page 15-16

Ethnographic interviews with a Grand Ronde tribal member John Wacheno a Clackamas Chinook in the 1930's also provided some basic descriptions of armor and weapons. His accounts tell of a rod armor for war, also "vest" of elk-neck-skin. Helmet like affair of elkskin. Small round shields of elk, "drum-like." The use of axes, double pointed knives, lances (used pike like).

Note the lack of extent examples from the Columbia River, and the known trade connections north for armor it became easy to identify and look for elk hide armor, and other forms of slat and rod wooden armor and the use of helms by Haida and Tlingit communities in British Columbia and South East Alaska we can see more recent examples of the armor in the contact era. I used these

Helms

As noted above by Franchere and Dunn the use of head protection was described as either a:

> "their heads are almost covered with a sort of helmet, the neck is almost the only part in which they can be wounded"

Or

> "and light casque of cedar bark, leather, or bear grass sufficient to protect the head from and arrow or a war-club".

There are no known examples either in ethnographic, museum or archaeological collections of an example of one of these head protections from the Columbia River. Given the descriptions the first could (I use this term in its most open context) be a basic description of a helm type used by tribes further north along the Pacific Coast such as the Tlingit and Haida who utilized wooden helms with a facial collar, or a reinforced cedar plaited or coiled basket hat. It is likely that the later was the more common style when any was available and if any example of a Haida example was here it likely was as much a wealth display item as armor. The main reason for bringing in this example is it is the closest example of an indigenous helm that could be replicated into Society of Anachronisms armored combat, and the choice I used to incorporate my heritage into my armor.

There is a great deal of research available on armor from the Pacific Northwest associated with this style[16]. The following images were utilized for the basic structure of the helm and then in conjunction with Vrin Thomasino modified to meet SCA armor requirements, and the art forms were taken from the Willamette Falls area where my family resided rather than using more northern communities' art forms.

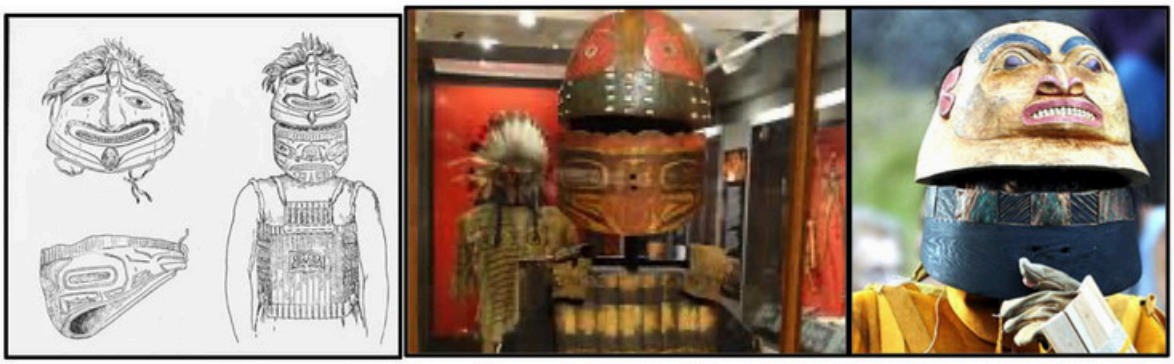
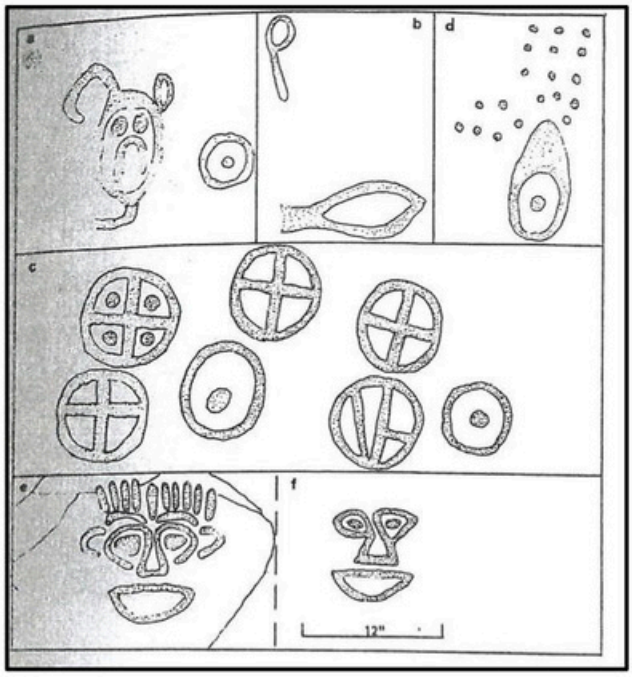


Image on left is from Primitive American Armor Footnote 16 and the image on the middle and right were found via an image search for from Google image under Haida and Tlingit War Helms.

Using the style of helm utilized by these northern communities as the basis I looked at examples of rock art near my ancestral village at the Willamette Falls and found the following replications that were selected and in the case of the face, it was modified to make it more intimidating but still meeting the style of art it was influenced from.

---

[16] Primitive American Armor by Walter Hough, Ph.D. Department of Ethnology, U.S. National Museum. H. Mis 184, pt. 2-40.
Conceptions of Coast Salish Warfare, or Coast Salish Pacifism Reconsidered: Archaeology, Ethnohistory, and Ethnography by Bill Angelbeck In Be of Good Mind: Essays on the Coast Salish, edited by Bruce Granville Miller, pp. 260-83. UBC Press, Vancouver.
Native North American Armor, Shields, and Fortifications by David E. Jones. University of Texas Austin Press 2004.



The image above is from the Willamette Falls and was replicated in Pictographs and Petroglyphs of the Oregon Country by L. Malcom Loring and Louise Loring. Institure of Archaeology, University of California Los Angeles Monographs 21/23. 1996.

Giving the examples above Master Vrin drafted this images as the base:

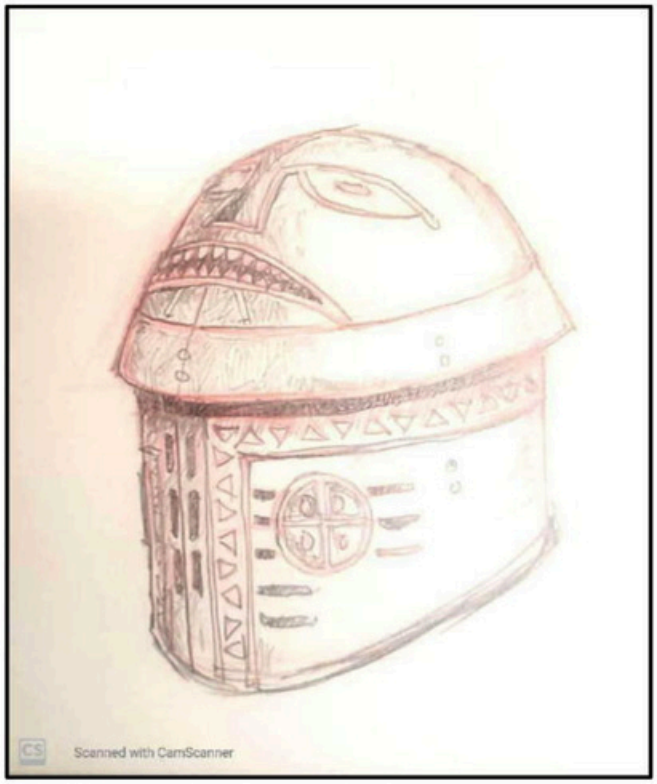
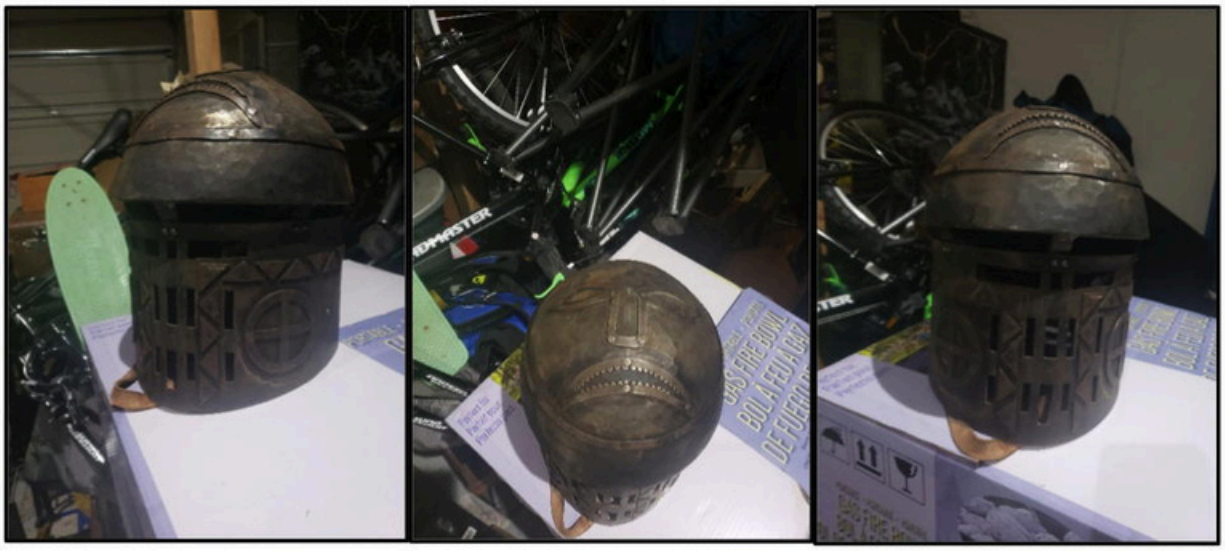


Image drawn by Vrin Thamasino 2021/22

For safety purposes and to meet Society Guidelines the helm is made in two parts to represent the historical build pattern but is connected by several tabs that are riveted to both the upper and lower parts but mimics the historical pattern of a two-piece head protection. The outside was also textured to represent the concept of the helm being made of wood.



The artistic elements are all sourced from the Willamette Falls area as noted above. The clamons is elk hide that has been sewn to represent the basic pattern of the clamons, but with a more modern interpretation on the art. The image on the front of the clamons is an image of a human body often seen in Chinookan art displaying a rib cage and emaciated or exaggerated set of hips. The back of the clamons is painted to represent the color pattern on the back of a sturgeon for symbolic purposes.

I hope this short article helps some folks understand my armor and where is comes from and what it represents for me.

Making Steel in the Middle Ages

Stephen C. Alter, 2017
aka: Baron Hrodr-Navar Hakonsson, OP
Entry in 2017 Arts & Sciences Fair and Pentathlon
Kingdom of Caid, Society for Creative Anachronism

7.6.1 Composition/Topic Paper

Introduction

Historians plot the development of human civilization in terms of the hardness and durability of materials used to make tools. Copper was the first metal to be exploited by man, as it was plentiful and could be collected in its pure metallic form. The Copper Age ended when societies learned to combine copper and tin to make bronze. This was not an obvious step. Someone figured out that by combining two materials, a third emerged which was more than its component parts. Thus we see beginnings of the science of metallurgy.

The Iron Age began when men made another intuitive leap and found that a useful metal could be created from rock. From the early Iron Age through most of the medieval period the only method to extract iron from raw ore was the bloomery[a] process which produced soft iron of low carbon content. It was not superior strength that caused iron to become the dominant metal. Early iron was not superior to bronze, only more plentiful. While copper was very common in early times, tin was in limited supply. Both iron and bronze were used by 3rd C Romans.[1]

Iron becomes harder as its content of carbon increases and it becomes steel. In time, various technologies were developed to make iron into steel which could be far superior to bronze, with dramatic effects on human civilization. Some historians have proposed that the Iron Age should be followed by a Steel Age, following the link between civilization and technology.[2]

An earlier paper discussed medieval technologies for extracting metallic iron from its ore.[3] The present work will explore how the products of the bloomery were transformed into steel for stronger and more durable tools, weapons and armor.

Iron Crystal Structure and Quenching

Metallic iron has a crystalline structure, which means that the iron atoms are arranged in a repeating three-dimensional grid or lattice. When heat is applied, the atoms vibrate. With

[a] See the Glossary in Appendix 1.

increasing atomic motion the whole lattice structure expands as the atoms start to move away from each other. Carbon atoms are the right size to slip through this expanding lattice and sit inside the iron crystal. If the heat source is removed at this point and the iron allowed to cool slowly, the carbon atoms will remain trapped inside, and this makes the iron crystal harder. [4] This is what we call *steel*. (see Table 1)

Like water, steel passes through the familiar phases of solid, liquid, and gas, but the situation is more complex in a very subtle but important way. Normal steel at room temperature exists in a specific crystalline structure called "ferrite." At 723 to 912 degrees Centigrade (°C) the iron and carbon atoms shift into a different arrangement called "austenite". The hot steel is still solid, the energized atoms are simply more stable in the new austenite configuration. If allowed to cool slowly, the atoms will shift back and the metal will revert to its original condition. But if hot steel in the austenite form is very rapidly cooled, the iron and carbon atoms don't have time to shift back into their former places and instead are frozen somewhere between ferrite and austenite, forming a new crystal structure called "martensite". Martensite is an extremely hard form of steel, much harder than would be predicted simply on the basis of carbon content alone.[5] Steel must contain a minimum of around 0.4 percent (%) carbon to see an increase in hardness after heat treatment.[6] This technique of rapidly cooling a red-hot piece of steel in water (called *quenching*) has been practiced since antiquity, as we see in Homer's *Odyssey* (c. 800 BCE):

> *As when a smith, in forging axe or adze plunges, to temper it, the hissing blade into cold water, strengthening thus the steel, so hissed the eyeball of the Cyclops round that olive stake.*[7]

Quenching was easy to do, but hard to control. Blacksmiths learned to recognize the colors of heated steel to determine the appropriate time to quench[8]. If the metal was too hot, or the change in temperature too fast, the object could crack.[9] In medieval times the processes

learned over a lifetime of trial and error would have been closely guarded secrets. Even if it didn't crack, the process of rapid quenching would often cause a steel object to become brittle. Imagine a steel bar heated to the perfect temperature and thrust into water. The bar does not become one big orderly crystal of martensite, instead cooling will begin at many points on the surface of the bar. With crystal formation beginning at many points the growing crystals bump into other growing crystals, leaving a patchwork of disjointed edges. The interfaces between separate crystal structures will be weak spots which are easily broken, which imparts brittleness.

Preventing brittleness is why steel is "tempered" after quenching. In the tempering step the steel bar is reheated … but not too much. If the bar is heated back to the formation of austenite (around 738°C) then the bar returns to its original form. This is called "normalizing". Gentle heating (up to 600°C)[10] allows the atoms at the crystal boundaries to move around into more stable positions, relaxing strain at the edges between neighboring crystals. Once cool, the bar becomes a more stable piece of interlocked martensite. Only in the 16th C do we begin to see records of both quenching and tempering being done in Europe. Prior to that, temper was what happened to steel when it was quenched[11] as in the quote above: "*plunges, to temper it*"

Giambattista della Porta (1589) provided the first European description of a tempering step (the author calls it a "return") performed after quenching on a coat of chain mail:

> *Take soft Iron Armour ... and make a good Fire about it: then at the time fit ... quench the whole Harness, red hot, in the aforesaid water for so it becomes most hard ... But because it is most hard, lest the rings of a Coat of Male should be broken, and fly in pieces, there must be strength added to the hardness. Workmen call it a Return. ... {T}hen make red hot a plate of Iron. and lay part of the Coat of Male, or all of it upon the same ... cast it again into the water, and that hardness abated; and will it yield to the stroke more easily..*[12]

One variation was the "partial" or "interrupted" quench, in which the hot steel was quickly immersed, and withdrawn before the piece had fully cooled. The heat retained in the

core of the object would radiate outward, and perform a bit of tempering on the martensite at the surface. This technique would be very difficult to control properly, particularly in a time without thermometers or timepieces, so consistent results were difficult to obtain. A more common method was to cool the hot steel slowly by quenching it in a dense liquid, such as oil. With a slower rate of cooling the conversion to martensite was not as complete (some of the austenite would revert directly to ferrite), but the forming martensite crystals had some time to adjust their boundaries, similar to the tempering process, but all in one step with the quench. This is called a "slack quench" and was documented in Roman times:

Table 1 Relative hardness of metals	Hardness VPH units[13]	
Pure Copper	50	14
Pure Iron	90	
Sterling Silver	100	15
Bronze	155 to 270	16
0.6% Carbon Steel, unhardened	260	17
" ,slack quench	400	
" ,water quench	800 or more	

> *It is the custom to quench smaller iron forgings in oil, for fear that water might harden them and make them brittle.* [18] (Pliny the Elder, c. 77 CE)

A German pamphlet published in 1532 (*Von Stahel und Eysen*, "On Steel and Iron") gives these two-stage quenching recipes, featuring an initial slow step in oil, followed by a fast quench in water as the hot steel plunges further into the bath:

> *Take tallow, heat it and pour into a vessel that contains cold water. ... {G}ently thrust whatever you wish to harden through the tallow so that it is hardened first by the tallow and then water.*
> *Take clarified honey, fresh urine from a he-goat, alum, borax, olive oil, salt; mix everything together and quench therein.* [19]

The quenching step was so critical yet poorly understood, that all manner of ingredients were tried in the search for that perfect quenching bath, e.g. blood, pigeon droppings, the urine of a small red haired boy, pomegranate, herbs, powdered horn, radish juice, morning dew, human excrement, earthworms, tadpoles, grubs and snails ("*including their little spiral houses*").[20]

The *Kunstbuch* and the Proper Use of Alchemy.

The Protestant Reformation had societal effects well beyond the method of worship and one's relationship to God. One of Martin Luther's reforms was to stress that each individual be able to read the Bible in his or her own language in order to interpret God's word for themselves, and to accomplish this everyone needed to be able to read. Thus in 16th C Germany we see a massive educational effort that did not discriminate between sex or social station. And to serve this growing literacy movement, the printing press came into its own. One item of great demand was the *Kunstbuch* (Art Book) that taught practical lessons in arts, crafts and household chores.

In 1535, publisher Christian Egenolff combined four *Kunstbuchen* into one volume called *Rechter Gebrauch d'Alchiemi* (*Proper Use of Alchemy*). To Egenolff, alchemy as practiced by mystics was "*smoke, ash, many words and infidelity*" and it was his intention to rectify the practice of alchemy by presenting its secrets "*for all skilled workmen*". What followed was an early attempt to provide scientific information to the layman. Egenolff avoided the complex arcane terminology used by alchemists and instead broke everything down into simple German, even providing translations of alchemical symbols and terms.[21] The first three parts of *Rechter Gebrauch* covered chemistry and techniques for goldsmiths, recipes for artists to make inks and colors, and instructions for use of chemicals in the dyeing and cleaning of clothes. The fourth part of *Rechter Gebrauch* was *Von Stahel und Eysen* (On Steel and Iron). This pamphlet was unique in its time for revealing the secrets of an art that must have in its own way seemed magical to the uninitiated. Some of the details might seem a bit far-fetched today (such as the use of urine, verbena juice and cockchafer grubs to quench steel) but as the rest of the pamphlet seems to come right from the blacksmith's workbench it may well be that these recipes are accurately reporting the state of the art as practiced in the 16th C..

From Roman times it was believed that the waters of certain rivers had superior quenching characteristics.[22] It has been suggested[23] that attributing the quality of their steel to the local river may have been a shrewd way for smiths to disguise secret methods.

The Medieval European Definition of "Steel"

According to today's iron and steel industry, the modern definition of steel is "iron that contains carbon in any amount up to about 1.7%",[24] however this is not the definition being used in medieval sources or even the modern historical literature. Medieval merchants knew the different abundance and properties of iron and steel, and priced them accordingly. (Table 2) In medieval Europe, iron was metal that could not be hardened by heat treatment (known today as mild steel), while steel was metal that could be hardened.[25] This does not mean that steel *must* be hardened to gain that name, only that it *could be* hardened. This is an important point, the quench-hardening step comes after the steel is fashioned into an object, so international trade in raw steel and iron would have dealt with unhardened materials. Smiths and merchants needed to be able to recognize the different metals in their raw form. Given that steel was in high demand but limited in quantity, metalworkers found other clever ways to make steel, or to make better use of what they had.

Table 2 Price of iron and steel in medieval England [26]

	Year			
	1300	1400	1500	1550
Iron	0.45 d	0.84 d	0.44 d	1.27 d
Steel	1.65 d	1.60 d	1.20 d	2.32 d

Average prices in pence (d) per pound

Case Hardening and Carburization

Imagine a bar of pure iron surrounded by carbon dust. As heat is applied, the iron atoms vibrate and the crystal lattice expands, allowing carbon atoms to diffuse into the lattice of iron atoms. The external surfaces of the iron bar are closest to the carbon, and so will absorb carbon first while the interior of the iron bar initially remains carbon-free. Time is required for the

carbon to diffuse from the outside to the inside of the iron bar. If allowed enough time, eventually the iron will absorb as much carbon as it can, and the resulting steel bar will be uniform throughout. If the heat source is removed before the process is complete, the carbon content will vary throughout the bar; highest at the surface, and lowest in the center. This process is called *case hardening* or *carburization* and was described by the Vedic physician Susruta c.700 BCE[27] for the hardening of surgical tools. Through Roman times this was accomplished by simply burying the iron object in hot coals[28], but the technique later evolved to encasing the object with carbon in a clay vessel.[29] After carburization, if the hot object is quenched, martensite will form at its surface. Theophilus (c. 1100) gives this advice for hardening the surface of a file:

> *These are made from soft iron ... {C}ut with a hammer or a chisel or a small knife, smear them with old pig fat* (a source of carbon) *and wrap them around with leather strips cut from goat skin* (more carbon) … *After this cover them individually with kneaded clay, leaving the tangs bare. When they are dried, put them into the fire, blow vigorously, and the goat skin will be burnt. Hastily extract them from the clay and quench them evenly in water.* [30]

By controlling the time allowed for carbon to permeate the piece of iron, one can obtain a piece of metal that is both hard on the surface and flexible at its core. Depending on the heat of the forge, one must allow 6-10 hours to get 0.4% carbon to a depth of 0.05 inch, or over 24 hours to get 0.4% carbon to a depth of 0.125 inch.[31]

Medieval smiths had limited amounts of good steel to work with, so they would combine it with softer iron in the making of tools. For example, a strip of hardened steel would be forge-welded onto an iron body in order to give a tool or sword a hard edge. In the technique called "piling", alternating strips of hard steel and softer iron would be forge-welded together to produce a tool or weapon that incorporated the hardness of expensive steel with cheaper soft

iron.[32] A version of this technique has also been called "pattern-welding"[33]. Pattern-welded blades are often marketed today as "Damascus steel", and the curious reader may find numerous published references and websites where modern blade smiths claim to be reproducing authentic Damascus steel. This technique was used by Romans[34], ancient Celts, Vikings[35], and Merovingian Franks[36] to make swords, and in more recent times to make gun barrels.[37]. While this method can produce an attractive damask pattern, and has the benefit of combining the flexibility of softer iron with the strength of harder steel, these are not true Damascus steel objects forged from a single cake of crucible steel (as will be described more fully below).

"Co-fusion" methods for making steel:

Pure iron melts at 1538 °C, but the presence of impurities will decrease its melting point. Iron with 0.5 % carbon melts at 1495 °C, and iron with 2 % carbon melts at 1154 °C. Once the iron crystal lattice melts, the liquid iron can rapidly absorb as much as 4.3% carbon, to become cast iron when it cools. Cast iron is hard and very brittle, and prior to the 14th C European smiths did not know how to turn cast iron into malleable steel. Thus the bloomery operator would avoid melting iron because cast iron was discarded as waste. The fact that the melting point decreases as the carbon content of steel increases illustrates one of the technical challenges to the bloomery operator. High carbon content is good, but high carbon content plus high temperature can spoil the batch. This also shows one of the advantages to the blast furnace and finery process that became common in the 14th C; just get everything hot enough so that it all melts. One doesn't have to finesse the line between steel and cast iron if one knows how to turn cast iron into a useable product.

While the medieval European smith avoided making cast iron, his Chinese counterparts made use of cast iron by combining it with soft iron to make steel. This approach to steel making has been called *co-fusion*.[38] There are records that this approach to making steel was

practiced in China as early as the 6th C[39], and there is one reference by al-Biruni suggesting that the method had migrated to medieval Islam by the year 1000[40] These sources show two ways in which co-fusion was practiced: 1) layering molten cast iron between bars of soft iron, and 2) spreading powdered cast iron between bars of soft iron before heating. In either process, the molten cast iron between two layers of soft iron will enable carbon to diffuse out of the cast iron and into the soft iron, making the cast iron softer and the soft iron harder. This approach does not appear in medieval Europe until Birignocio (1540, *"Pirotechnia"*) described the following process:

> *Thus they keep it and turn it again and again so that all that solid iron may take into its pores those subtle substances that are found in the melted iron, by whose virtue the coarse substances that are in the bloom are consumed and expanded, and all of them become soft and pasty.* [41]

Trade Secrets and the 16th C Military Industrial Complex

Vannoccio Biringuccio (1480-1539) was a metalworker, and at times inspector and purchasing agent for the Florentine military.[42] As such he would have been shown secret processes that would have been state of the art in his day. Such an official could also leak sensitive information to the competition, after all, he wrote a book on metallurgy from his experiences, and wrote "*…my intention is only to tell you the method of making them, in order that what most masters hold as a very great secret may be manifest to you.*"[43] It is quite possible that a government contractor might show him the factory, but not disclose the entire process. Modern practitioners have tried to duplicate the method as written down by Biringuccio but it doesn't quite seem to work exactly as written.[44] Biringuccio's accounts of metallurgy are remarkable for their time in being factual and evidence based, as opposed to the mysticism that pervaded alchemical treatises of the time. "*I have no knowledge other than that gained through my own eyes.*"[45] So while he may have faithfully recorded what he was told, it is possible that he wasn't told everything.

The solid iron didn't melt because, as discussed above, low carbon iron would melt at a higher temperature than does high carbon cast iron. The solid iron bar absorbs carbon, and in time it becomes "*soft and pasty*" (i.e. with increasing carbon content it is approaching its melting point at the temperature of molten cast iron.)

Crucible Steel

The bloomery process produced iron and steel of varying carbon content, but mostly low carbon iron. Even bloomery steel is limited to at most 0.8% carbon, due to the low melting point of high carbon steels. Anything above 2% carbon is cast iron, hard, brittle and unworkable. Steel of 1% to 2% carbon would be very hard with some brittleness but still workable, however this range was mostly out of reach for early smiths. The limiting factor of the bloomery was the presence of an excess of carbon; if high carbon iron was allowed to melt it would rapidly absorb more carbon and become cast iron. The idea behind crucible steel is that soft iron is sealed in a container with a limited amount of carbon, then heated to melting. If an excess of carbon was present, this would produce cast iron. But if, for example, only 1% (by weight) of carbon were added to the crucible, then the molten iron could only absorb at most 1% carbon.[46]

Another method to achieve the same end would be to mix pieces of soft iron and cast iron in a closed crucible.[47] If equal quantities of the two are combined and melted, then the resulting ingot will have carbon content half-way between the two. With either of these methods one could achieve a carbon content of 1% to 2%. Having the steel melt in the crucible provided another significant benefit. Bloomery iron always[48] contained bits of non-metallic rock left over from the smelting process (slag). Slag inclusions in iron artifacts would contribute to brittleness and breakage. In a crucible, molten steel will separate from molten slag (the slag floats on top), producing a clean homogenous metal. So crucible steel benefits by being both cleaner and higher carbon than the average bloomery product.

al-Kindi on iron and steel

Ya'qub ibn Ishaq al-Kindi (c. 800-870) was known in Europe as "The Philosopher of the Arabs", quite an honor when one considers the other great minds who contributed to Islam's Golden Age. One of the first scholars to lead Baghdad's House of Wisdom (combination library, research institute and scriptorium), he made significant contributions to philosophy, theology, optics, geometry, astronomy, and medicine and wrote on a host of other topics, including the cause of thunder, lightning, snow and rain; pigeon breeding, bees, and the making of swords. [49] In two works produced during the reign of caliph Mu'tasim (c.840) we see a very detailed account of iron and steel metallurgy in the 9th C Islamic world. [50]

> *Know that iron ... is divided into two primary categories: mined and unmined. The mined is itself divided into two categories: hard iron, which is male, hard, and able to be quenched during its forging; and soft iron which is female, soft, and cannot be quenched.*

This designation of male and female iron was used in Islamic literature for centuries afterward. "Mined" iron is the metal as it comes from the bloomery, containing pieces of low carbon content, and some higher. We now identify female iron as having less than 0.4%, and male iron as having greater than 0.4% carbon. Steel is only produced as a secondary process, and so is "unmined":

> *...unmined iron, it is steel. It is manufactured from mined iron by adding to it during the melting something which refines it and makes its softness strength so that it becomes firm and pliable.* [23]

What al-Kindi identifies as "steel" is what we call "crucible steel". The "something" that is added to make mined iron strong is carbon.

The crucible steel process is currently believed to have originated in India, and may date from as early as 300 BCE[51]. Historical sources tell us that there were many types of crucible steel available. It is generally agreed that much of this crucible steel came from India in medieval times, although there is evidence that it was also produced in Central Asia[52], Moorish Spain[53] and Iran (however the Iranian steel was deemed to be of poor quality and we are told that Indian steel was more desirable.)[54] The medieval Arabic word for steel referred only to crucible steel, and simple high carbon (male) iron from the bloomery was considered inferior:

> *Swords may be forged from the male type, but they are dry swords that break quickly when they encounter adversity ... {S}o almost no one would forge from them except one ignorant or in need in a place where there is only male iron.*[55] (Al-Kindi, c. 860, *"On Swords and Their Kinds"*)

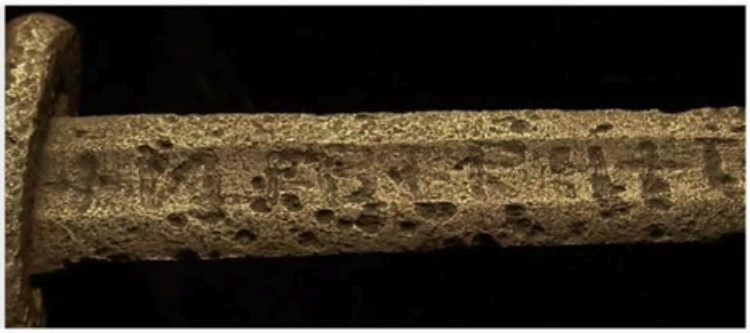


Figure 1. Viking era "Ulfberht" sword."[57]

Certain Viking-era swords have been found in Scandinavia that contain better quality steel than was commonly available elsewhere in the west[56]. These swords (or the steel from which they were made) were most likely crucible steel made in the East and shipped to Scandianvia. The technology for making crucible steel, however, didn't catch on in the West until the 18th C.[58]

Indian crucible steel is known today as "Damascus steel" or "Wootz."[59], and is best known by the attractive wavy pattern it often shows. Islamic authors referred to the patterns as "water", only found on a high quality Indian steel blade:

> *It has a water whose wavy streaks are glistening. It is like a pond over whose surface the wind is gliding.* [60] (Aws bin-Hadjar, c. 540.)

In the perfect weapon, the extreme of sharpness lay hid, like poison in the fangs of a serpent; and the water of the blade looked like ants creeping on the surface of a diamond.[61] (Hasan Nazaimi, c. 1200, "*The Crown of Exploits*")

Figure 2. Persian Shamshir, dated 1606-7. The writing on the blade reads: "Abbas, the slave of the ruler of the land. Oh God. Oh Ali."[62]

Being an ultrahigh (1 to 2%) carbon crucible steel, Wootz/Damascus steel was very hard and able to hold a very sharp edge. This is documented in the quotes above, as well as by other contemporary Islamic authors and later western observers who praised its hardness and the sharpness if its blades, but who also recorded that Indian steel had a reputation for brittleness, also to be expected for ultrahigh carbon steel.

Their swords are made crooked like a falchion, very sharp but for want of skill in those that temper them, will break rather than bend; and therefore we often sell our sword blades at high prices that will bow and become straight again.[63] (Edward Terry, 1616)

Crucible steel was the highest quality steel available in the Middle Ages, and rightfully demanded a premium price. Although weapons get much of the attention, it is known that crucible steel was used in other applications as well, including wire for musical instruments[64], files, scissors[65], mirrors[66] and farm implements[67]. Indian steel was certainly an important commodity in medieval times. However modern archeology is discovering evidence that medieval production and use of crucible steel was much greater than had previously been thought, and was not limited to Indian "Damascus" steel.

International trade in precious metals

India has been known as a major exporter of iron and steel since antiquity.

2nd C: Import fees from the reign of Marcus Aurelius show large amounts of *ferrum indicum* being imported by Rome[68]. It is not known how much of this was soft iron, and how much was crucible steel, but the 2nd C alchemist Zosimos of Alexandria described the process of making crucible steel, and said that it had been invented in India.[69]

6th. C The Byzantine Empire recorded Indian steel among its imports in 565 CE.[70]

9th. C**:** Al-Kindi (ca. 840) documented that crucible steel in the Arabic world came from India (*al-Hind*, the land of the Hindus).[71]

10th. C: Li Shizhen, (Chinese physician and philosopher) wrote: *"Bin iron, which is produced by the Western Barbarians, is especially fine. It is so hard and sharp that it can cut gold and jade.* [72] "Bin" (also "Bin-tie") was the Chinese word for crucible steel.

10th. C: There are references to "Indian steel" armor being used in Moorish Spain in 985 CE. By the early 13th C crucible steel was being manufactured in Seville by Islamic smiths, but after the city was retaken by Christians in 1248 the production of crucible steel ceased.[73] Christian Europe showed little interest in the technology for hundreds of years.

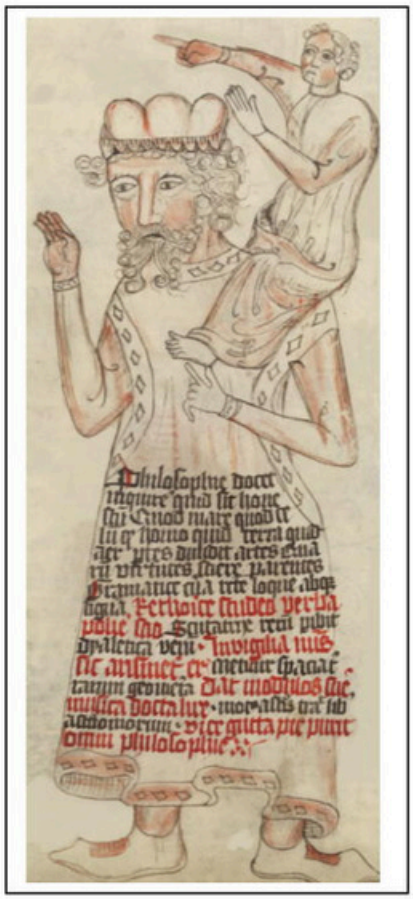
11th to 13th C: In a fascinating collection of business letters dated from 1080 to 1240, we learn that merchants supplying Indian iron and steel to the rest of the world identified five different products: "refurbished" (scrap iron), "regular iron" (wrought iron), "eggs" (crucible steel ingots), "shiny" (polished crucible steel, used for mirrors and jewelry) and "smooth" (crucible steel beaten into bars). [74]

19th C: Egerton (1896) states that since the 15th C, the best Damascus steel swords were made in Persia, using steel imported from India. [75]

Conclusion

The history of technology is the history of human civilization, from the use of sharpened sticks through the development of space age materials to take us farther and faster. The sophistication of steelmaking technology used in the Middle Ages is a testament to the creative ingenuity of our forbearers, particularly in light of the fact that they did not understand the molecular processes involved as we do today. It would indeed be a mistake to claim that modern man is in any way more clever or more intelligent than medieval craftsmen and scientists, or the philosophers of antiquity who preceded them. Communication and the written word allow us to share information across the millennia, so that our rapid technical advances today are firmly grounded in the work of those early pioneers. Sir Isaac Newton (1675) wrote:

"*if I have seen further, it is by standing on ye shoulders of giants*." [76]



Interestingly, even this quote has roots in an earlier age. The philosopher Bernard of Chartres (c. 1124) wrote over 500 years earlier:

> *We are like dwarves perched on the shoulders of giants, and thus we are able to see more and farther than the latter. And this is not at all because of the acuteness of our sight or the stature of our body, but because we are carried aloft and elevated by the magnitude of the giants.*[77]

Figure 3: *Encyclopedic manuscript containing allegorical and medical drawings*, Germany, ca. 1410.[78]

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Blast Furnace

A furnace used to extract iron from its ore, not common in Europe until the 14th C. Iron ore mixed with charcoal is continuously fed into the top of the furnace. Iron oxides in the ore react with carbon to form free metallic iron and carbon dioxide, and the molten iron (and molten slag) flow downward to collect at the bottom of the furnace. Molten slag, floating on top of the iron, is tapped off, then the molten iron is drained. With raw material fed in from the top and the end product drained from the bottom, the blast furnace could be operated continuously, providing much greater efficiency and quantities than were possible with the *bloomery*. The cooled product of the blast furnace, called *cast iron*, was reheated in a secondary process called the *finery* to produce workable iron.

Bloom, Bloomery

The *bloomery* is an ancient type of furnace used to extract iron from its ore. Charcoal and crushed iron ore would be mixed and heated. Iron oxides in the ore react with carbon to form free metallic iron and carbon dioxide. The temperature of the furnace is maintained below the melting point of iron, which is semi-solid and coalesces into a loose spongy mass called a *bloom*. The *bloomery* was largely replaced in 14th C Europe by the *blast furnace*.

Brittleness

The tendency of an object to shatter when force is applied. Iron is made brittle by an inconsistent internal crystalline structure. Increasing carbon concentration in steel makes it harder, but more brittle. Brittleness can also occur if hot iron is cooled very quickly (*quenching*), where the crystals are locked in an irregular pattern and may fracture along the interfaces of the mismatched crystal lattices. Also, iron containing impurities from the original ore will tend to be brittle. The most resilient iron is that which has a consistent internal crystalline structure.

Cast Iron

A name for the product of molten iron produced in a bloomery or blast furnace, containing carbon above 2 percent. Cast iron is very hard and brittle, and could not be worked by medieval smiths until around the 14th C, with the discovery of the *finery* process. Prior to that, smiths would avoid producing cast iron, and when they did it was considered a waste product.

Crucible Steel

Soft iron is sealed in a container with a limited amount of carbon, then heated to its melting point. In this way the carbon content can be controlled to produce steel in the range of 1 to 2 percent carbon.

Finery

In a *finery*, cast iron produced by the *blast furnace* was reheated in an open hearth, exposed to the air. Excess carbon in the cast iron combined with oxygen in the air and escaped as gas. In this way, hard unworkable cast iron could be made malleable by decreasing its carbon content.

Forge-welding

Combining two pieces of metal by heating both and hammering to fuse the pieces together.

Hardened Steel

Quench Hardening

A process of hardening steel objects by heating, followed by cooling to increase the hardness substantially. *Slack Quenching* used dense liquids (often oil) that allowed slow cooling, and better control of the process. *Full Quenching* was done by taking the glowing item out of the forge and immersing immediately in water for very rapid cooling. The process results in the formation of *martensite*, which greatly increases hardness of steel. To avoid brittleness the object would be *tempered*.

Case Hardening (aka Carburization)

A process by which low carbon steel has been further processed to increase the carbon content (and *hardness*) at the surface of the object. This is achieved by embedding the object in powdered charcoal, then heating below the melting point of iron. The iron object absorbs additional carbon on its surface, producing a very thin layer of increased carbon content. When the hot object is cooled rapidly (*quenched*) the iron crystal lattice freezes into a particularly favorable configuration known as *martensite*, which confers exceptional hardness.

Hardness

The ability of a metal to absorb force without deforming. Higher carbon content in iron confers increased hardness, and converting high carbon iron to *martensite* increases its hardness even further. The typical test for hardness (the Vickers Pyramid Hardness test: VPH) is to measure the indentation made by a weighted object dropped from a standard height. This property dictates the ability of a weapon (or tool) to take an edge, or a piece of armor to take blows without bending.

Iron

The most common metallic element in the earth's crust. *Iron* can refer to the pure metal, but is also commonly used as a general term for any ferrous metal. C*ast iron* specifically refers to iron which has melted in the presence of excess carbon during its manufacture. *Bloomery iron,* the product of the medieval *bloomery*, was not molten in its manufacture.

Medieval European definition: Product of the *bloomery* that cannot be hardened by *quenching*

Medieval Islamic definition: Any product of the *bloomery*.

Martensite

A particular crystalline structure of steel that is much harder than untreated steel. Martensite is created by heating untreated steel, then *quenching* in oil or water.

Slag

Impurities in the process of iron processing. Non-ferrous rock (mostly silica) is an impurity to be removed in the smelting process. The term is also used to refer to residual non-ferrous impurities in a finished iron object.

Steel

Modern definition: Iron that contains carbon in any amount up to about 1.7 percent.

Medieval European definition: Product of the *bloomery* that can be hardened by *quenching*

Medieval Islamic definition: What we call today *crucible steel*

Cover Page:

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[42] Williams, *Sword and Crucible,* 217

[43] Smith and Gnudi, 388.

[44] Williams, *Sword and Crucible,* 217

[45] Smith and Gnudi, 42.

[46] This is a gross oversimplification, but it gets the point across.

[47] Medieval Arabic smiths are known to have produced cast iron on purpose for this use.

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Submission Information

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PLEASE CONTACT THE SUMMITS CHRONICLER IF YOU SEE ANY ERRORS - THANK YOU!

Officers of Court

Order of the Shield of Summits (formerly the Shield of Chivalry): Temperance Trewelove
Defender of Summits: Antoine a la Langue d'Or
Captain of Cats: Allejandro Romero
Sword of the Mountain: Adriano Foscari
Captain of Eagles: William Cristofore of Devonshire
Alpine Scholar: Dawnhela Heartsblood of Briaroak
Summits Hunter: Eoghan Ua Cleirigh
Skald of Summits: Gaius Aurelianus Felix
Cut & Thrust: Jerric Kaldheim