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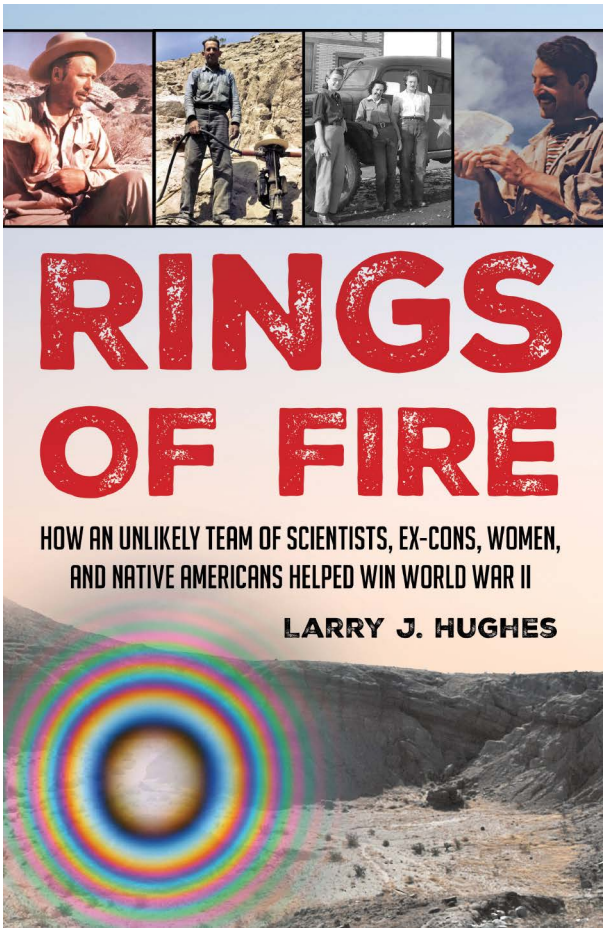
Book Review

Book Review: Rings of Fire: How an Unlikely Team of Scientists, Ex-Cons, Women, and Native Americans helped win World War II (2024) By Larry J. Hughes. Globe Pequot/Stackpole Books. ISBN: 978-0-8117-7389-8, 600 p. $34.95.



What is your relationship with the uniaxial optic axis interference figure? Maybe optical mineralogy was your favorite undergraduate class, and you can sketch the directions for O-ray and E-ray vibrations to this very day. Or maybe interference figures were the bane of your undergraduate education, and you still cringe when you think about them. Or perhaps you've never taken a course in optical mineralogy, and you have no idea what a uniaxial optic axis interference figure is. (No problem—there is an app(endix) for that!) Or maybe you are like me and know all about calcite and its high birefringence and distinct interference figure, but you have no idea that calcite played a role in the outcome of World War II. But why not calcite? Why not use the interference figure, with its brightly colored concentric rings, as a gunsight on military artillery? Just put the melatope on the target and pull the trigger. In reality, it is a bit more complicated than that, but you get the picture. *Rings of Fire,* by Larry J. Hughes, geophysicist and artist, takes us on a World War II adventure like no other—one in which optical mineralogy plays the hero.

Rings of Fire chronicles the Optical Ring Sight (ORS) program from 1941 through 1945, pioneered by Edwin Land and Polaroid Corp. and funded by the U.S. Department of War. The story winds its way from Edwin Land's invention in New England through calcite mines in California, Montana, and Mexico. The myriad twists and turns that ensue, often funny and sometimes heart-wrenching, obtain their richness through the people and the unique challenges faced by the ORS program. During WWII, inventors and businessmen like Edwin Land and geologists like Harry Berman, Arnold Hoffman, Robert Hoffman, and Arthur Montgomery were employed and remained stateside, as did the USGS geologists Cordell Durrell, James Gilluly, Walter Stoll, and Frank Armstrong. However, the normal workforce that would have provided the personnel for calcite exploration, mining, and processing was largely deployed to military operations, leaving an interesting group of people to supply the calcite needed to make the optical ring sights.

The cast of characters is too long and detailed to mention in its entirety, but some personalities stand out: John Hilton, California artist and miner; Al Hansen, Bob Dye, and Jack Frost, miners and finaglers in California and Montana; Edwin Stanton, out-right liar and FBI impersonator in Mexico, who dragged Navy Captain K. Howard Noble and local rancher and businessman Ben Williams along for the ride. John Hilton and Irwin D. Hoffman earned fame for their paintings of California landscapes (Hilton) and people (Hoffman). The stories of military service members are woven through the book, from officers at the Department of War to the Marines who drove the trucks in California. The post-mining active-duty service of two miners, Cecil Kegan and Harry Sikkenga, is detailed, giving the honor due to those who served in the War. Members of the Cahuilla Native American tribe found work as miners in California and contributed their

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culture to the mix. Salvador López, Steve and Dave Modesto, and Dan Segundo—these men navigated the cultural boundary between Indigenous and white.

The subtitle of this book is "How an unlikely team of scientists, ex-cons, women, and Native Americans helped win World War II," which in today's culture feels a bit jarring. Are women not included in all those other categories? But not so in WWII America. The ORS calcite mine in Montana presented an interesting challenge; rather than rhombohedral or scalenohedral crystals, the calcite was found in lumpy potato-shaped masses, making it difficult for miners to determine if samples had the correct crystallographic dimensions to make the optical ring sights. Enter the "Crystal Crackin' Mamas"—Irene Frederick, Hazel Adams, Peggy Tregloan, Helena Bowlds, Minnie Winn, and Sally Pahrman—a group of Montana women ready to contribute to the war effort. Their job was to find the optic axis of each potato calcite, cleave the crystals into appropriate dimensions, and inspect for optical flaws such as inclusions and twinning. Men were at war or working in the mines—could women do the job? Of course, they could and have a mighty fine time doing it!

The second aspect of Hughes' storytelling that makes this tale so compelling is the portrayal of the invention, production, and implementation of new technology. Design of the ORS continued throughout the project in response to new challenges. When calcite production dropped perilously, other materials with similar optical properties were sought. Could sodium nitrate replace calcite? Rapid exploration and production of sufficient calcite drove the opening of mines in California, Montana, and Mexico, each with its own challenges of ownership and operation. Personalities as big as the Wild West bred rivalries, unlikely friendships, and nefarious deeds. Mining an easily cleavable mineral has both advantages and challenges. During wartime, sample screening and production must be brought online rapidly. There is not time to spend a year designing a manufacturing facility and another year building it. Rent a building and make the sights now! Or, better yet, yesterday. Bureaucracy was slow then, as it is now. Getting payment to people in rural locations across the country was not easy and led to dissatisfaction on the part of some miners, who were already living on lean income. In addition to these challenges, the question of acceptance of a radically new type of gunsight loomed over the whole project. If the soldiers didn't use it, everything else would be for naught.

The last chapter is worth the wait and well worth the read. This chapter discusses post-war uses of the optical ring sights and finishes the stories of the players in the book. The sights were used in some interesting applications….no spoiler alert is necessary here because this review will not divulge them. You will just have to read the book to find out.

The book includes several appendices. The first one has a very nice description of the physics of the optical mineralogy that makes the sights work, including a discussion of the circular polarization that eliminates the melatope and isogyres, leaving the center clear for targeting. In addition, the specifications and uses of the optical ring sights, calcite mine production, and a list of Irwin D. Hoffman's artwork from the California mining period are detailed.

Why should you read this book? I will give you four reasons. First, Hughes traipses down the rabbit holes that we call human relationships and shows how we are tied together in unexpected ways. He successfully passes through these narratives and comes out on the other side back into the main story such that you don't even realize that you just learned a lot about history and sociology. A few examples include Edwin Land and his work, the Cahuilla Native American tribe, stories of active-duty soldiers in WWII, and life in the American West during wartime. Second, the book is extremely well researched, with extensive chapter notes based on personal and phone interviews, newspaper reports, personal papers, emails and letters, technical papers, photographs, patents, and FBI records. The book includes a brilliant set of photographs and images that supplement the story. This research, stretching over a decade, is very thorough. For example, in one of the post-war applications (this review will not divulge what they are), Hughes was able to determine that 26 optical ring sights were issued to a certain location, but only 24 have been recovered. There are two of them out there, somewhere; perhaps a field trip to retrieve them is in order? Third, *Rings of Fire* offers insights into the waste of human potential through prejudice and stereotypes by all countries involved in WWII. However briefly, the ORS project brought together ex-cons and military personnel, indigenous peoples and privileged millionaires, put women in technical positions, and showed that they all could work together, finding strength and talent in each other that they would have otherwise overlooked. And finally, *Rings of Fire* describes a mineralogy-based business with investors and detractors, surpluses and deficits, hard-working employees and parasites—it describes the path of many of today's start-ups. The book is good business reading that shows how innovative technology struggles against the resistance to something different than "the way we've always done it."

Calcite is such a humble mineral. It is seemingly everywhere, in limestone, marble, hydrothermal deposits, and the pipes in your house. Its common uses are fundamentally important but not very glamorous: concrete, toothpaste, and the manufacture of glass, steel, paper, plastic, and rubber. *Rings of Fire* helped me remember the magic of calcite: The way its cleavage causes it to fracture into tiny rhombohedral replicates of itself. Its magnificent double refraction and high birefringence. This book made me fall in love with calcite all over again. I hope the same for you.

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