Introduction

"Wow!" is the most common exclamation heard when people set foot on an earthen floor for the first time. It's usually followed by "It's beautiful!" or, more often, "What is it?" There is something foreign and strange about an earthen floor, yet something familiar and comforting. For people who are used to concrete, tile, hardwood or carpet, taking a step onto an earthen floor is a refreshing change.

Most people are unfamiliar with the idea of an earthen floor, and are understandably skeptical. "Aren't they dusty?" they ask. When people imagine an earthen floor, they probably

A beautiful earthen floor in Crestone, CO. (Credit: James Thomson)

think of a dirt floor in a small shack in a village in a faraway country, or maybe something from the past. While this type of primitive floor can actually be quite comfortable if cared for properly, the earthen floors described in this book are a modern adaptation of these ancient techniques. Today's earthen floors are attractive, durable and excellent options for modern homes.

The basic ingredients in earthen floors are simple: sand, clay and some sort of fiber (usually chopped straw). Other additives may include pigments for color and manure for extra fiber. Finally, once applied and fully dried, the floor is sealed with coats of drying oil and wax.

People love the unique look and feel of earthen floors. They come in a range of dark, rich earth tones, often flecked with lightly colored fibers. They feel different, too: walking barefoot over an earthen floor is a starkly different experience from walking on a concrete floor. The first obvious difference is temperature: earthen floors feel warmer to the touch. Second, an earthen floor is softer than a concrete floor. The difference is subtle, but important. Anyone who has worked a job that required standing or walking on a concrete floor knows the impact on the body of working on a rock-hard surface. Many have experienced that standing and working on earthen floors is easier on the body. Finally, the minor undulations and irregularities that are a result of the hand-troweling process more closely mimic textures and patterns that we might expect to find in nature and feel more natural to our feet, like walking on the earth.

(Credit: Mike O'Brien)

This book will describe the history of earthen floors, give best practices for where and when to use them and provide

step-by-step instructions for installing a floor from scratch. It is intended to be a practical guide for DIYers, contractors, architects and anyone with an interest in trying their hand at this amazing practice.

The authors (and others in the natural building field) have developed the installation techniques described here over more than a decade of work. This doesn't mean they're the only or even the best way; they're simply a way that has been shown to work over time and in a variety of circumstances. Building is a creative practice. Builders develop their own techniques and methods that work well for them, and readers will likely modify and adapt the suggestions in this book for their own purposes. Building with earth is different from other kinds of building. Because earth is a locally sourced product, it is inherently unpredictable. What works in one location with one type of soil may not work somewhere else. People who choose to pursue expertise in this field should be prepared for surprises and challenges as they learn and gain experience.

No book can teach everything there is to know about any topic, and this one is no exception. The intention is to provide enough information to improve the odds for success, and to prevent readers from making some of the many mistakes the authors have made. But mistakes will invariably happen anyway; hopefully they will be opportunities for further learning and development rather than causes for despair.

The Authors

Sukita Reay Crimmel

I feel connected to my human history working with the raw ingredients I use to make earthen floors: the lineage of humans using what is locally available to make shelter. Like a cook in a kitchen, I feel a relationship with the properties of clay, sand, straw, oil and wax and find simple inner joy in blending these ingredients to create beauty. The process involved in transforming these materials from piles into floors has taken my breath away again and again. The shimmer of the clay, the strength of the sand, the color of the

Sukita Reay Crimmel.
(Credit: Miri Stebivka)

straw and the support of oil and wax delight me. I feel like a connector of our ancient past to our modern present. Something about these floors feels sacred, especially when the materials come from our own digging at the location we are building. The experience of community among those installing the floor often brings out joyful play. The floors take on all this joy of creation and ongoing admiration. What a beautiful foundation to life!

At college I studied architecture. The University of Oregon was known for its green building program, and through my coursework and involvement with a student group, I found out about natural building. The simple beauty of earthen architecture got into my heart and lit my passion! Hands-on experience was to be my teacher for some time, learning how these materials performed beyond the embodied energy numbers and thermal qualities I had learned in school. After a couple of years working for a progressive builder in Eugene and engaging in the natural building community on the West Coast, I moved to Portland, Oregon, in 2002 and began to engage with natural building in an urban environment.

I started a contracting business (From These Hands) that specialized in earthen plasters, earthen floors and other earthen features. In 2007, my focus on earthen floors was turned up a notch with press coverage of my work in the *New York Times*.

In 2011, I started Claylin LLC, a manufacturing company that produces a ready-mix earthen floor blend, as well as sealing oils and a finish wax. I offer these products to ease the questions and challenges of new recipes and to bring earthen building materials into

a market that is unfamiliar with them. It has been my mission to rekindle the connection, knowledge and confidence to build with the earth. And it is my intention with this book to help those who will create their own recipe or use Claylin to have the support of my years of learning. It brings me great joy to collaborate with my friend and colleague James Thomson in writing this book.

James Thomson. (Credit: Miri Stebivka)

James Thomson

When I was eighteen, I took my first trip to the Pacific Northwest. Growing up in New England, I had spent plenty of time in the woods, but the woods of the Northwest were something different entirely. On the Olympic Peninsula, towering trees and mountains dominated the landscape for as far as the eye could see. But there was something else unfamiliar, too: clear-cuts. These huge scars on the landscape hit me like a punch in the gut. It was easy to make the connection between the conventional construction industry and the havoc it wreaks on our fragile environment.

I first became interested in natural building as a way to help preserve these (and other) forests. I wanted to learn to build in a less destructive way, with materials that were all around us and whose use would leave a smaller scar on the landscape. In 2004, I moved to Southern Oregon to learn to build with earth and straw, and have been "covered in mud" ever since.

I soon realized that natural building is not just about swapping one material (earth) for another (wood/concrete/vinyl). It is about fundamentally re-evaluating how we live, rather than just what we

live in. It's about changing our relationship to the structures that shelter us, from one that is mostly financial in nature to one that is more holistic, that values how we really want to live over how much our investment grows.

Building with earth is one way to help us deepen our connection with our homes. The unique aesthetic it offers reminds us of the larger Earth outside our door. It's also a technique that leaves a light footprint on the environment and doesn't bring a lot of toxic junk indoors.

And best of all, earthen building techniques are accessible to novice builders. Like all things, they require practice to develop skill, but the materials are safe and forgiving and, perhaps more importantly, fun to work with. I find that most people have an innate connection with working and playing with earth. Maybe it's from early memories of making sandcastles on the beach or mud pies in the backyard on a hot summer day. Or maybe it's because these materials are all around us; they make up our world, they make up *us*.

I poured my first earthen floor in the summer of 2004. I couldn't believe that such simple materials could make such a sturdy floor; even after years of installing them, I'm still sometimes surprised that they work so well. Earthen floors are a great starter project for budding natural builders. The process is similar to concrete floors, as is the aesthetic, and many find it more accessible and realistic than more radical techniques like cob or straw bale. And best of all they can be installed in most preexisting homes, with minimal alterations to the existing structure. I feel grateful to have connected with Sukita Reay Crimmel several years ago; working with her has greatly increased my understanding of and appreciation for earthen floors. Together we hope to demystify this amazing technique and make it available to you, now. I hope you'll welcome some earth into your home with an earthen floor!

Sukita and James join forces…

Writing this book has been a truly collaborative process. We began in late 2011, but had already established a friendship and working

relationship by then. Our writing collaboration started with the instruction manual for Sukita's earthen floor product Claylin. Creating this manual made us realize how much experience and knowledge we had collectively accumulated, and wetted our appetite for writing a more general-audience book.

In the spring of 2011, Sukita met Heather Nicholas from New Society Publishers at the *Mother Earth News* fair in Puyallup, WA. Heather encouraged Sukita to write a book about natural building; the obvious choice was earthen floors. Realizing that this would be a big undertaking, Sukita asked James to collaborate on the project, and he agreed.

We have each brought our own skills and knowledge to this project. Sukita has established herself as a nationally renowned earthen floor expert, and has installed over 20,000 square feet of earthen flooring. James has brought not only his own hands-on experience but also an eye for writing and editing. We've spent many, many hours together over the past two years, and can happily report that we still get along well! It has been a near-perfect collaboration, with each of us feeling like we could not have done the project without the other. Over the months, the information in this book has been written and rewritten, with the hope of creating a clear, straightforward and definitive guide to all things earthen floor.

SECTION 1

ABOUT EARTHEN FLOORS

The idea of living on a floor made of earth is not new; humans have been doing that for centuries. What is new is the idea of bringing these ancient materials into our modern homes. It is valuable to understand where the techniques used today came from, and how earthen floors are different from (and similar to) other flooring options, in order to make sure they are installed in appropriate settings. (Photos: Left: James Thomson, Right: Miri Stebivka)

CHAPTER 1

The History of Earthen Floors

Building with earth has been a staple of human civilization for millennia. Confronted with the question of how to shelter themselves, our ancestors looked around and found an abundance of natural building materials right under their feet.

600-year-old "Hakka" communal earthen structure, China. (Credit: © Liumangtiger | Dreamstime.com)

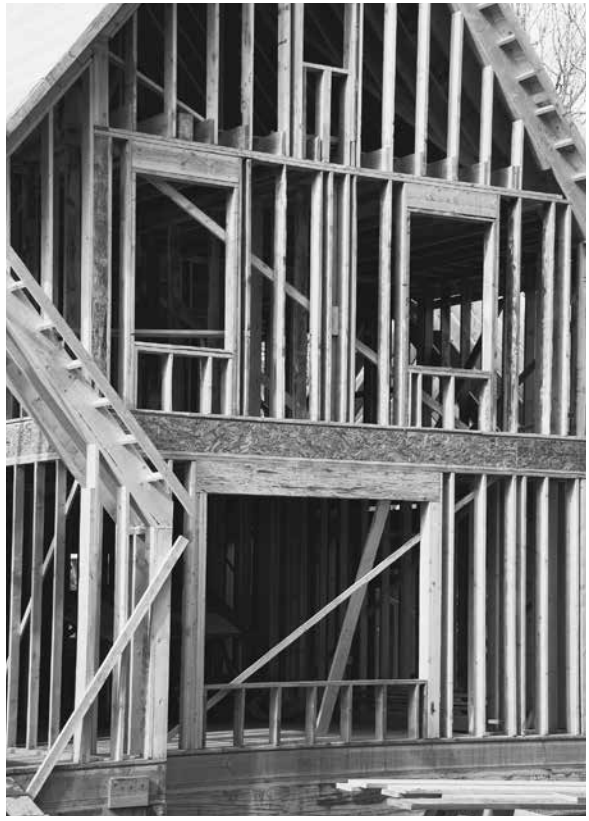
Using soil, sand, rocks and plant fibers, they built durable and comfortable buildings that would stand for generations. They used these same materials to add smooth, attractive finishes, providing bright, beautiful and durable interiors and exteriors. For most of human history, people have lived in houses that they (or a family member) had built from materials found close by. In many parts of the world, these ancient traditions are still in use today.

Earth is abundant and ubiquitous. Trees don't grow everywhere, but the earth is always underfoot. There are several earthen building techniques that readers may be familiar with. The most widely known is sun-baked clay bricks, often referred to as adobe. There is evidence that ancient Egyptians made mud bricks more than four thousand years ago (2000 BCE). Every continent on Earth has ancient structures built from mud or clay bricks. Here in the US, there are many examples of ancient adobe buildings, including the oldest continually occupied structure in North America: Taos Pueblo in New Mexico, about a thousand years old. Other common earthen building techniques are waddle and daub (mud plaster smeared over a matrix of woven sticks), cob (similar to adobe, but without the bricks) and sod (bricks of earth and roots cut from the earth). Earthen plasters, sometimes mixed with manure and natural pigments, have been utilized to beautify and preserve earthen dwellings. Human societies the world over have employed these (and similar) techniques for thousands of years to create shelter. And these techniques are still in use today; it is estimated that a quarter to a third of the world's population lives in houses built partially or entirely of earth.[1]

During the industrial revolution and the population (and building) boom that followed, many of these traditional techniques were displaced by new materials and building designs, such as lightweight wooden structures framed with wooden studs that could be erected quickly and cheaply. A new industry of building product manufacturers arose to satisfy the insatiable demand for more houses. By "outsourcing" much of the materials preparation to these manufacturers, buildings could be built even faster.

This once-new paradigm has become the standard in developed nations. Building products manufacturers, from lumber companies to paint companies, continue to make and sell products that allow buildings to be completed in a fraction of the time it would have taken our ancestors just three or four generations ago.

Yet this time saving has a cost: not only a financial cost but also a cost to the health of our planet and our bodies. The buildings industry is one of the most destructive forces on the planet, producing toxic chemicals that we are encouraged to put in our homes (paint, wood treatments, formaldehyde, glues)



Wooden stud framing in progress. (Credit: © Picstudio | Dreamstime.com)

Scars on the landscape left behind by logging operations. (Credit: © Steve Estvanik | Dreamstime.com)

Buildings Are the largest contributor to climate change

(adapted from Architecture 2030: Climate Change[2])

According to the US Energy Information Administration (EIA), the building sector consumes nearly half (48.7%) of all energy produced in the United States, about the same amount of energy consumed by transportation (28.1%) and industry (23.2%) combined. Globally, these percentages are even greater. Most of this energy is produced from burning fossil fuels, making the building sector the largest emitter of greenhouse gases on the planet — and the single leading contributor to anthropogenic (human-created) climate change. Nearly half (46.7%) of all CO_2 emissions in 2009 came from the building sector (transportation accounted for 33.4% and industry just 19.9%). With so much attention given to transportation emissions, many people are surprised to learn these facts.

and leaving vast swaths of clear-cut or strip-mined land in its wake.

The environmental impact of a building doesn't end when the last contractor leaves the building site, either. As the evidence for climate change becomes overwhelming, the calls for changing the status quo are growing louder.

This book is not intended to address all of these challenges, but it does pose a possible answer to the question "Is there a better way?" The Earth provides an incredible abundance of durable, non-toxic and beautiful building materials that can be found almost anywhere. Our ancestors knew this. Can we learn, again, how to use them?

The rise of "green building"

In the 1970s, rising awareness of environmental pollution coupled with an energy crisis spurred the growth in North America of what has come to be known as the green building movement. Green builders strive to improve the energy efficiency of new buildings and to use materials that are less toxic and more sustainably produced. Adhering to the philosophy that the "greenest" building is the one that is already built, they also work to retrofit existing structures for improved energy efficiency as well as creating spaces that are more pleasant to work and live in.

A whole industry has arisen to address the concerns of those who struggle with the destructive nature of the conventional construction

industry. Green building, from whole building design to remodeling materials, is on the rise.

Natural building

"Natural building" is a relatively new term that describes a building philosophy that emphasizes sustainability through using minimally processed, locally available, plentiful and renewable resources to create healthy living environments. Natural builders value handmade and site-processed materials over store-bought products and favor small, thoughtful buildings over large, extravagant ones. Green buildings tend to rely more on green building products that have been manufactured to meet the growing needs of the industry, while natural building eschews products when locally available materials will suffice. Natural building is still a very small fringe movement, but technical books on natural building processes continue to become available, and building codes are being rewritten to be more accepting of natural building practices.

Earth is a favorite building material of natural builders,

A remodeled bedroom in a 1926 Craftsman-style home,with earthen plaster walls and an earthen floor. (Credit: James Thomson)

and earthen building has seen a small renaissance in the last two decades here in the United States and around the world. What started as a movement of homesteaders and off-the-grid DIYers has grown to where it is now possible to find earthen building projects in many urban areas of the most developed countries. Germany, for example, has a small but thriving earth-building culture, where historic and new buildings alike have been updated and built with earthen materials. In Portland, Oregon, a growing natural building movement has brought earth building into the urban environment; there are many public gathering spaces created out of earthen materials, and there are "conventional" houses that have been retrofitted with earthen paints, plasters and of course floors.

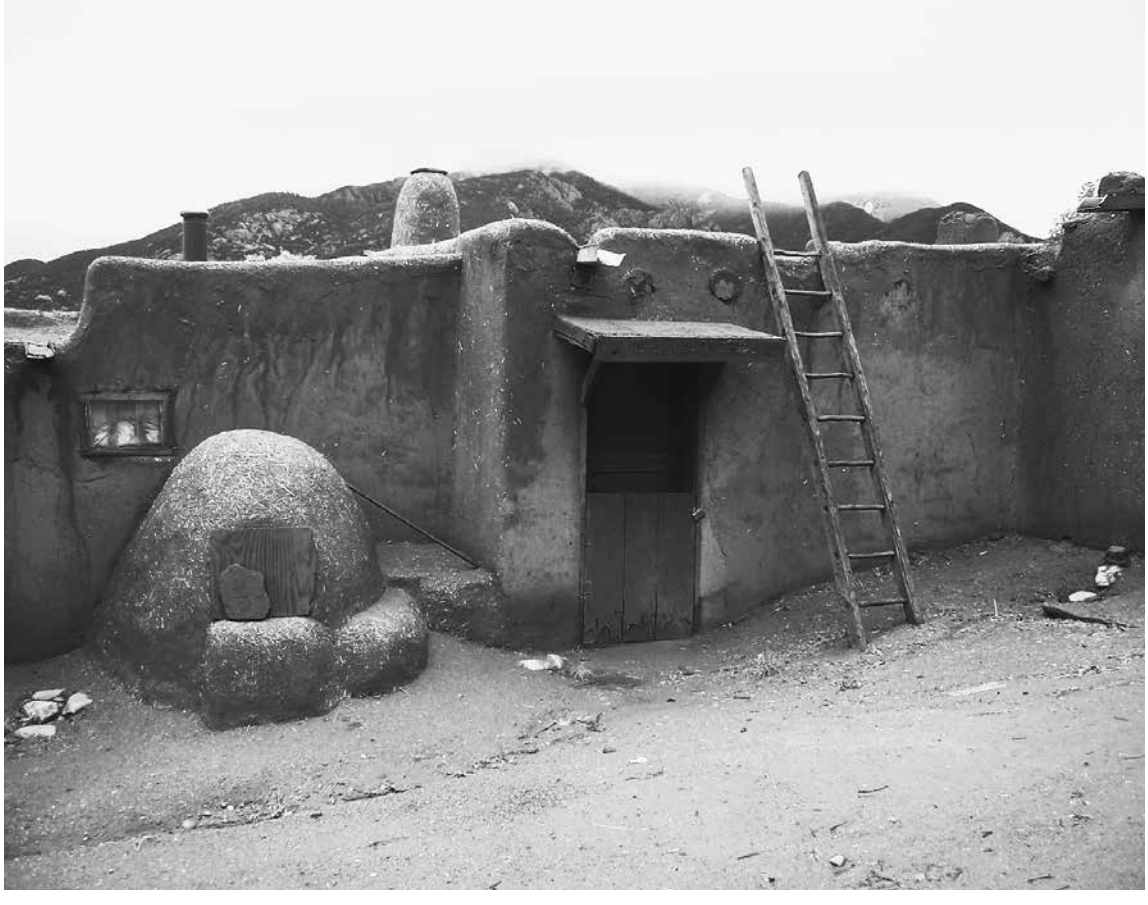
Earthen floors are a great option for those who want to bring earth into their homes. The technique is relatively easy to learn, and the floors can be installed in all types of existing buildings. They sell themselves on their aesthetics alone, without even considering their unique feel, low toxicity, minimal environmental impact and thermal benefits. They can be applied in a variety of situations and conditions, and are suitable for most general-use rooms. These are modern earthen floors.

Earthen floors

The concept of an "earthen floor" is not new. Homes have been built directly on the earth for many millennia. As late as 1625, most European houses had a tamped earthen floor, and visitors had to wipe their shoes on an entry mat to make sure they didn't get it muddy or dusty. Early settlers in North America lived directly on the earth, like the many generations of Native Americans who preceded them. As the colonies expanded and industrialized, the abundance of wood available brought about the plank wood flooring of the Colonial Era (1607–1780) and earthen floors fell out of favor.[3] Still, in many parts of the world, it is not hard to find people living on floors made of earth. Sometimes the residents use sealers, to stabilize the earth more permanently; examples of simple, low-cost sealers include ox blood, ghee, vegetable oils and even used

motor oil. More typically, traditional earthen floors are just the raw earth beneath the house, tamped down with human feet and moistened frequently with water to keep the dust down.

The modern revival of earthen floors in North America has its roots in the homes and buildings of the native southwest of the United States, which maintained "traditional" (raw) earthen floors into the twentieth century. As people moved into more conventional modern homes, the techniques became less and less used until they were almost lost entirely. Yet a small number of craftspeople continued the practice. The lineage of the "modern earthen floor" can be traced to three early practitioners.



Taos Pueblo, the oldest continuously occupied dwelling in North America, is built from earth.
(Credit: James Thomson)

Anita Rodriguez.
(Credit: Don Roberts)

Anita Rodriguez: Growing up in New Mexico, Anita was surrounded by adobe buildings. Traditionally, the finishes in these buildings, including the plasters and floors, were applied and maintained by women, who were known as *enjarradoras* ("plasterers" in Spanish). In the 1970s, Anita was inspired to learn the trade of earthen plasters and floors, and she sought out the women who still knew the skills. Much of their knowledge was being lost as their communities collapsed and modern construction practices were adopted. Anita took what she learned from these women and continued to experiment for years, integrating earthen materials into her construction business. Anita picked up the use of linseed oil, a widely available sealant, from a colleague and incorporated its use into her practice.

Bill and Athena Steen: The Steens have been integral in spreading the technique. While writing *The Straw Bale House,* they came in contact with Anita. Bill writes:

> [Anita] had come up with a method for doing adobe floors that didn't crack. At that time, most adobe floors were poured three to four inches thick. At that thickness, they typically cracked, largely because adjustments to the site soil were rarely made. Those cracks were often patched before sealing the floor, giving a look like rustic flagstone. The woman with the crack-free

Bill and Athena Steen. (Credit: Bill Steen)

adobe floors was Anita Rodriguez.... We secured a job for ourselves doing an earthen floor and we wanted to use Anita's method. We compensated Anita for her formula from revenues earned on that job and we were on our way. About the same time we wrote a very simple booklet on the technique, every now and then one finds a copy in some obscure location. The essence of Anita's method were applying two half-inch coats as the finish for the floor and then sealing them with four coats of heated and progressively thinned coats of linseed oil.

Bill Steen:

My favorite floors were always those that were nothing more than plain dirt and were renewed with dampening and sweeping on a regular basis. Those were primarily in Mexico. My mother continued dampening and sweeping the yard around our home as I grew up, a practice common in the patios of many old homes in southern Arizona. It made the earth smell fabulous.

The Steens developed the process further and started using insulation:

> I think one of the major changes we adopted was to switch from using off-the-shelf boiled linseed oil, that is toxic and foul smelling, to using sun-thickened raw linseed oil that we produced ourselves. We also started adding insulation beneath the floors and separating them from the ground with adequate drainage where needed.

And finally, they gave the floors the name we use today:

> We coined the term "earthen floors" in order to make it clearer to a wider audience instead of how they were known in our part of the world, "adobe floors." From that point they seemed to really take off.

Sukita:

I first learned how to make earthen floors from my time working with Robert Bolman in Eugene, Oregon. Robert learned what he knew from Bill Steen. And today as I continue to learn, with lots of trial and error, I am personally inspired and excited to find a connection with Anita Rodriguez and my fellow *enjarradoras*.