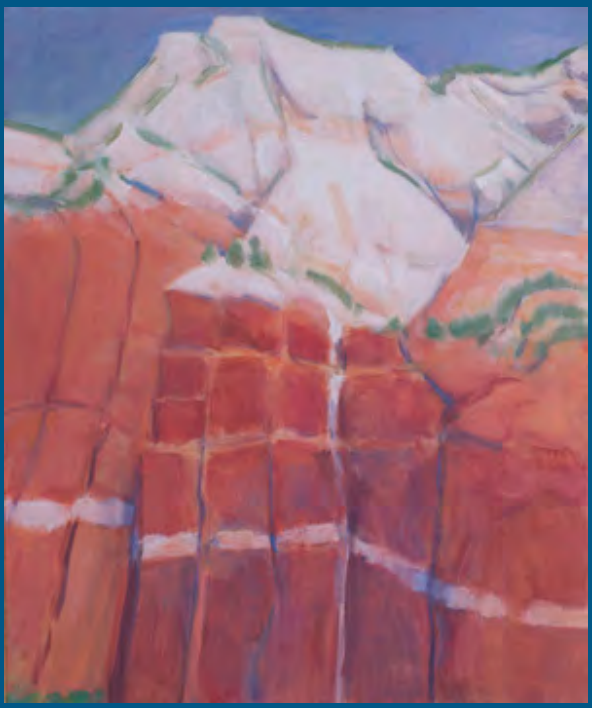
GEOLOGY IN THE FIELD



Robert R. Compton

Robert R. Compton (1922–2015) was born and raised in Los Angeles. From an early age he enjoyed spending time in nature and as a youngster would escape the city to go camping with his brother in the Mojave Desert. He attended Stanford University, where his love for the outdoors likely influenced his decision to major in geology. He received his undergraduate (bachelor's) degree in 1943 and his graduate degree (PhD) in 1949. Between his two degrees he served in World War II. From 1950 until his retirement in 1981, he was in charge of teaching Stanford's field camp – the final, intensive summer course for undergraduate geology majors on how to make a geological map. In 1962 he published *Manual of Field Geology*, which soon became a classic. In 1985 he published a revised manual – *Geology in the Field* – that continued to serve as the definitive guide to geological mapping.

His other passion was art and, after many sporadic forays into painting while working as a geologist, he took it up full-time in retirement. The painting above is of Mount Diablo, with its distinctive double pyramid peaks, often visible to the east of the San Francisco Bay area. It captures a common theme in his abstract landscape paintings – a fascination with color and form viewed from the eyes of a geologist and an artist. The painting is unsigned and simply labeled #41. It is one of over a hundred canvases he painted (robertrcompton.com), some of which appear in this ebook edition.

Robert R. Compton
Stanford University

GEOLOGY IN THE FIELD

To my students.

Design: Candace Compton-Pappas

Illustration: Robert R. Compton

Cover: Robert R. Compton
White and red sandstone, Zion National Park, Utah 1990 (52 x 43 inches)

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■ Foreword

I have many fond memories of being with my father in the Great Outdoors. As a family we often went on weekend hikes in the San Francisco Bay area and spent holidays camping in the Sierra Nevada. When I was older my father took me with him (along with my other brothers) when he went off to map, either on our own or as part of the Stanford geology field camp that he ran. The location of the field camp varied over the years from the nearby coastal ranges of California to the remote Grouse Creek Mountains of Utah and Santa Rosa range of Nevada. He treated me and my brothers as he did his students, a tough task master who expected a lot from us. He was driven by a keen desire to explore the rocks and what they could tell us. And it wasn't just the rocks; he had broad interests that included the landforms, the plants and the birds, as well as the beautifully crafted obsidian arrowheads that could be found by keeping a sharp eye to the ground. He also taught us to keep an eye out for rattlesnakes and to steer clear of badgers. He was tall and lean and walked in long, purposeful strides. Students were advised to get in shape before camp, as it was not unusual to cover 10 or more miles in a day over rugged ground without roads or trails. We often struggled to keep up, hoping the next outcrop would occupy him a good while before he bolted off again up the next ravine.

Back then I never imagined that I, too, would end up a geologist. My undergraduate major was in chemistry, but with a minor in Earth Science that steered me into doing a PhD in geochemistry. I remember the thrill near the end of my undergraduate field camp when everything I had been exposed to in classrooms and gleaned from textbooks for the first time all fell into place and I truly understood much of what I had learned. Over the years, I have had occasion to help teach field courses while at the University of Cape Town. I was initially surprised to discover my father's manual in the UCT library when I arrived, and it hit me just how far and wide its influence was. I suspect his book can be found in many other university libraries around the world, because for a long time it was the only one of its kind.

People often speak of leaving a legacy, something that will live on beyond them and continue to influence others. In addition to his artwork, my father's legacy as a professor of geology is undoubtedly his textbook, *Geology in the Field*. Sadly, his book has been out of print for several years, making it difficult to get hold of a copy. Those who have the book often insist that their younger

students borrow theirs, so long as they swear to return it! My father retired before the advent of the desktop PC. Although he often liked to boast half-defiantly that he had never used a computer, he did ask his publisher John Wiley & Sons about having an electronic or digital version of his book made available for students. But an ebook version was never produced. After my father died in 2015 I requested reversion of the publishing rights back to his estate, which the publisher kindly granted. Reading through his book again, I realize there is so much that rings true even now, 30 years after it first appeared. Certainly, much has changed in our conceptual understanding of how the earth works, but the lucid writing and abundant line drawings are still hugely relevant in terms of what is most important in learning how to map. There are many geologists teaching field courses who believe that as great as the new technology is, it is desirable to have students learn to map the 'old-fashioned' way: traversing the landscape on foot, recording observations in field notes and sketches, working from topographic maps and aerial photographs, and constantly thinking about how to interpret what they see into a geological story.

I didn't have the time to revise my father's book, so I decided to focus on making the ebook version he had wanted and in the process make it available to students once again. The advantages of an ebook are many. It can be produced relatively quickly, and made accessible through the internet to a global audience. It can easily be referred to in the field on mobile devices and can be reasonably priced in comparison to most university textbooks (my father was upset to learn what students had to pay for his book and did what he could to get the publishers and book retailers to keep the price under control). I have tried to reproduce the book essentially as it was in an electronic format (pdf) that is of high enough resolution to be printed for those who prefer a paper version to an electronic book. And I didn't have to look far for a publisher, as I had recently established Earthspun Books to publish several of my own books. An ebook should last forever (in theory), and it is my hope that my father's field manual will remain available into the future as part of his legacy, reflecting his passion for the natural world, for geology and for helping students to understand our earth and how it all fits together.

John S. Compton
Cape Town, South Africa
April 2016
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Preface

Geology has evolved greatly since I wrote the *Manual of Field Geology* in the 1950s. Advances in theory have transformed the formation mapping of that time into increasingly broader and more interpretive studies. We have much to seek at the outcrop, and the rising costs of field work compel us to recognize key features the first time around. In addition, mapping and data collecting must be more consistent and accurate than ever. This book is intended as a guide for these modern studies. Its form is compact so that it can be carried in the field, yet most procedures are spelled out completely. Half the book consists of brief descriptions of textures and structures helpful in interpreting depositional environments, kinds of volcanic activity, and plutonic events and conditions. To encourage full interpretation during the field season, procedures are included that are often reserved for the laboratory or office: staining rocks, correcting orientations of current indicators, constructing profile sections of folds, measuring strains, making photogeologic interpretations, and so on.

Broadly, the book proceeds from pre-field considerations to methods of observation and measurement, and then to recognition of key geologic features, and finally to preparation of a report. Chapter 1 presents the general philosophy of field geology together with the steps in a typical field project. Chapter 2 describes field equipment and its uses, and Chapter 3 observation, interpretation, and accumulation of information. Hand-lens identification of textures and rocks is the subject of Chapter 4, and Chapter 5 describes how to recognize and trace rock units and structures, including the details of a pace and compass traverse. Geologic mapping on a topographic base is covered in Chapter 6 and mapping on aerial photographs and other remote-sensed imagery in Chapter 7, the latter including sections on photogeologic interpretation and on compilation of photo data. Chapter 8 covers mapping with the plane table and alidade, including surveys of control systems. Structures and depositional environments of marine and nonmarine deposits are described in Chapters 9 and 10, and measurement and description of stratigraphic sections in Chapter 11. Chapter 12 presents summaries of tectonic structures and melanges, and Chapters 13, 14, and 15 primary features of volcanic rocks, of plutons, and of metamorphic rocks. The final chapter describes ways of planning and preparing geologic

illustrations and reports. Fourteen appendixes provide systematized data and procedures.

In order to make the book as compact as possible, involved or special methods that can be anticipated before the field season were omitted. Underground mapping, for example, requires many safety precautions and specific instructions, and is well described elsewhere. Trigonometric tables were kept to a minimum because of the general availability of pocket calculators. Many of the drawings are generalized or composite in order to save the space that would have been needed for more specific examples.

In 1980 I corresponded with many instructors who had used my manual, asking for criticisms and suggestions. The following persons provided useful ideas and materials: A. K. Baird, S. S. Beus, W. A. Braddock, M. L. Bregman, P. W. G. Brock, E. R. Brooks, V. M. Brown, G. H. Davis, J. Deen, J. A. Dorr, Jr., P. L. Ehlig, V. Fischer, D. R. Foutz, R. E. Garrison, C. A. Hall, Jr., C. W. Harper, E. A. Hay, H. E. Hendriks, J. F. Karlo, M. Kay, S. R. Kirkpatrick, S. A. Kirsch, R. G. Lawrence, W. E. LeMasurier, K. A. McDonald, D. F. McGeary, R. G. McWilliams, M. E. Maddock, W. D. Martin, M. A. Murphy, T. L. Pewe, K. J. Schulz, K. Servos, R. L. Shreve, P. Snavely, III, L. A. Standlee, C. A. Suczek, A. G. Sylvester, A. N. Ward, Jr. and H. Zantop.

A number of persons and organizations answered questions, offered valuable advice, or supplied copies of papers or other materials during the writing stage: T. H. van Andel, W. R. Dickinson, L. G. Duran S., J. R. Dyer, Earth Sciences Associates, W. R. Evitt, J. H. Fink, R. V. Fisher, R. W. Galster, R. E. Garrison, the Geological Survey of Canada, R. T. Holcomb, C. M. Isaacs, D. L. Jones, J. R. Keaton, D. K. Keefer, V. A. M. Langenheim, R. V. Laniz, D. K. Larue, C. McCloy, G. Mahood, D. M. Miller, E. L. Miller, T. H. Nilsen, B. M. Page, T. L. Pewe, J. B. Pinkerton, M. C. Powers, E. I. Rich, the Shell Oil Company, M. F. Sheridan, D. A. Swanson, A. G. Sylvester, R. L. Threet, P.-J. Uebel, and the U.S. Geological Survey.

Persons who read completed chapters or parts of chapters and provided many valuable criticisms and suggestions are: E. R. Brooks (Chapters 2, 4, and 15), Lindee Glick (Chapter 12), H. E. Hendriks (Chapter 7), R. T. Holcomb (first half of Chapter 13), J. R. Keaton (the tables and engineering geology section of Chapter 5), G. Mahood (Chapter 13), N. McLeod (first half of Chapter 13), C. Meyer (the hydrothermal alteration part of Chapter 15), D. M. Miller (Chapter 12 and Appendix 7), E. L. Miller (Chapter 12), R. J. Newberry (part of Chapter 15), T. H. Nilsen (Chapter 9 and part of Chapter 10), B. M. Page (the melange section of Chapter 12), T. L. Pewe (Chapter 10 and part of Chapter 7), A. G. Sylvester (Chapters 1, 3, 5, 6, and part of 7), and V. R. Todd (Chapter 14, part of Chapter 12 and Appendix 7). In addition, the manuscript was reviewed for John Wiley & Sons by F. R. Ettensohn, R. L.

Kaesler, and S. H. Wood, who each suggested a number of improvements.

The staffs of the Branner Library and the Department of Geology at Stanford were very helpful. Lyn Dearborn and Dave Olson typed and computerized the manuscript, making many corrections in it. Last and far from least, the staff at Alphabetics/Design With Type, especially my daughter Candace, made many improvements during design and composition.

Robert R. Compton

Robert R. Compton
Faulted basin of volcanic tuff between ranges of red volcanic rock (36" x 40") 2012

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