

Palaeomagnetic database: the effect of quality filtering for geodynamic studies

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Abstract: The Global Palaeomagnetic Database (GPMDB), now updated to 1992, contains about 7000 palaeomagnetic data, which are fundamental tools to define regional and global geodynamic models. A software developed at the Istituto Nazionale di Geofisica allows the selection of data on the basis of space, time, and quality. Six quality classes have been proposed. The African and European Apparent Polar Wander Paths (APWPs) have been computed and the role of the statistical uncertainties is discussed. Some examples from the Tethys Belt have been chosen to demonstrate the effect of the quality filtering in geodynamic studies.

In the last few years, the International Association of Geomagnetism and Aeronomy (IAGA) has officially encouraged the development of several palaeomagnetic and rock-magnetic databases, which fulfil the need of storing and easily handling the increasing amount of data coming from several palaeomagnetic disciplines: among others rock-magnetism, archaeomagnetism and magnetostratigraphy. In particular, five regional databases of directions and palaeopoles were compiled by Khramov & Pisarevsky (Russian Federation), Pesonen (Fennoscandia), Enkin (Canada), Luyendyk & Butler (USA) and Westphal (Europe). Besides the regional databases, IAGA was the sponsor of the world-wide database, the Global Palaeomagnetic Database (GPMDB), co-ordinated and published by McElhinny & Lock (McElhinny & Lock 1990a, b, 1993; Lock & McElhinny 1991). IAGA also encouraged cross checking of the regional databases with the global database, so that errors and omissions were avoided. The GPMDB synthesises all the palaeopole parameters and their quality, and its updated version contains about 7000 palaeopoles. The collection for the period 1989–1992 has been performed by Van der Voo. The GPMDB has a complex file structure, and includes data produced for completely different aims, such as magnetostratigraphy, determination of virtual geomagnetic poles (VGP), averaged palaeomagnetic poles etc. Consequently the data must be selected and weighted according to the scientific field in which the palaeopoles are to be used. The problem of quality filtering is the subject of this paper.

The tectonic framework

Data originating from the GPMDB are referred to specific areas (Fig. 1) which include Africa (excluding Madagascar), Europe to the Urals and part of Asia (Middle East, Caucasus and Arabia). Traces of various orogenic episodes can be found in Africa, Europe and Asia: the two Palaeozoic events (Caledonian, 570–370 Ma; Variscan–Hercynian, 370–220 Ma) and the Alpine Mesozoic–Cenozoic orogeny (Early Mesozoic Alpine, 220–65 Ma; Mid-Cenozoic Alpine, 65–20 Ma; Late Cenozoic Alpine, 20 Ma to present) (UNESCO 1976; Bally *et al.* 1985). The Caledonian orogeny was active in the Mauritanides (Africa) and in Scandinavia, Scotland, Wales and the Ardennes (Europe). Cratonic basins, located mainly in continental pre-Mesozoic lithosphere and shields deformed by Pre-Cambrian orogenic episodes, can be found alongside the Caledonian orogenic belts. Most of Africa has a cratonic structure, such as in western Africa, Congo, Tanzania and Kalahari, with other old deformed areas like Katanga. In Europe we can notice both old deformed zones, like the Karelian system and Fennoscarmatian shield, and wide craton basins (e.g., the North Sea Basin and the Russian–Ukrainian Basin). The Variscan–Hercynian orogeny is strongly marked in Morocco, southern African Cape, in Europe in the Central Massif, the Variscides and the Urals. In Africa the Mesozoic–Cenozoic Alpine orogeny affected the Maghrebides and the Cape Range. The rift-valleys of East Africa were formed during the Neogene and are still volcanically active.

Palaeomagnetic Database

Kent C. Condie, Victoria Pease



Palaeomagnetic Database:

The Global Paleomagnetic Database Jo Lock, M.W. McElhinny, 2012-12-06 Document Syntax XI I DATABASE DESIGN 1
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Palaeomagnetic Database J. D. A. Piper, 1988 *Palaeomagnetism and
Tectonics of the Mediterranean Region* Antony Morris, Donald Harvey Tarling, 1996 The Mediterranean region represents a
complex mosaic of continental microcontinental and ophiolitic terranes whose overall evolution has been controlled by
relative movements between the African and Eurasian plates Palaeomagnetic studies have played an important part in
deciphering the sequence of tectonic events in this region The 33 papers presented here span the full width of the
Mediterranean basin and present results from Permian to Quaternary rocks Paleomagnetism Michael W.
McElhinny, Phillip L. McFadden, 1999-10-18 Paleomagnetism is the study of the fossil magnetism in rocks It has been
paramount in determining that the continents have drifted over the surface of the Earth throughout geological time The fossil
magnetism preserved in the ocean floor has demonstrated how continental drift takes place through the process of sea floor
spreading The methods and techniques used in paleomagnetic studies of continental rocks and of the ocean floor are
described and then applied to determining horizontal movements of the Earth's crust over geological time An up to date
review of global paleomagnetic data enables 1000 million years of Earth history to be summarized in terms of the drift of the
major crustal blocks over the surface of the Earth The first edition of McElhinny's book was heralded as a classic and
definitive text It thoroughly discussed the theory of geomagnetism the geologic reversals of the Earth's magnetic field and
the shifting of magnetic poles In the 25 years since the highly successful first edition of *Palaeomagnetism and Plate Tectonics*
Cambridge 1973 the many advances in the concepts methodology and insights into paleomagnetism warrant this new
treatment This completely updated and revised edition of *Paleomagnetism Continents and Oceans* will be a welcome resource

for a broad audience of earth scientists as well as laypeople curious about magnetism paleogeography geology and plate tectonics Because the book is intended for a wide audience of geologists geophysicists and oceanographers it balances the mathematical and descriptive aspects of each topic Details the theory and methodology of rock magnetism with particular emphasis on interpreting crustal movements from continental and oceanic measurements Outlines Earth history for the past 1000 million years from the Rodinia super continent through its breakup and the formation of Gondwana to the formation and breakup of Pangea and the amalgamation of Eurasia Provides a comprehensive treatment of oceanic paleomagnetism Provides a set of color paleogeographic maps covering the past 250 million years Written by two internationally recognized experts in the field

Palaeomagnetic Database J. D. A. Piper, 1991-08-15 Provides an in depth analysis of global paleomagnetic results from the earliest studies right up to mid 1987 Reconstructing the movements of each plate over geological time then developing corresponding paleogeography of the past requires a time sequence of paleomagnetic poles for each of the tectonic divisions comprising the total crustal area This database presents worldwide paleomagnetic information in just such a form with data listed plate by plate in order of decreasing geologic age

Palaeomagnetism in Fold and Thrust Belts: New Perspectives E.L. Pueyo, F. Cifelli, A.J. Sussman, B. Oliva-Urcia, 2016-08-23 Palaeomagnetism is a technique used to understand complex deformation patterns in fold and thrust belts it can be used to characterize the distribution magnitude and timing of vertical axis rotations an elusive variable using other methods A combination of palaeomagnetic and structural geology analyses has helped to unravel the geometry and kinematics of fold and thrust belts around the world and of different geological ages for more than 50 years This volume comprises three sections the first shows thorough overviews of western Mediterranean arcs and the western Carpathians the second depicts several examples from the Andes the Alps Anatolia Pyrenees Iberian Ranges and the Atlas and the third shows the latest research on the use of palaeomagnetism to understand fold and thrust belts in 3D and 4D in a more quantitative way and it also includes some methodological proposals to avoid common errors In the papers of the first two sections the combination of palaeomagnetic analyses with structural data AMS or magnetostratigraphic analyses demonstrate the usefulness of palaeomagnetism in deciphering complex deformation patterns in fold and thrust belts

The Geological Record of Neoproterozoic Glaciations Emmanuelle Arnaud, Galen P. Halverson, Graham Shields-Zhou, 2011 In recent years interest in Neoproterozoic glaciations has grown as their pivotal role in Earth system evolution has become increasingly clear One of the main goals of the IGCP Project number 512 was to produce a synthesis of newly available information on Neoproterozoic successions worldwide This Memoir consists of a series of overview chapters followed by site specific chapters The overviews cover key topics including the history of research on Neoproterozoic glaciations identification of glacial deposits chemostratigraphic techniques and datasets palaeomagnetism biostratigraphy geochronology and climate modelling The site specific chapters include reviews of the history of research on these rocks and up to date syntheses of the structural framework tectonic setting palaeomagnetic

geochronological constraints physical biological and chemical stratigraphy and descriptions of the glaciogenic and associated strata including economic deposits **Supercontinent Cycles Through Earth History** Z.X. Li,D.A.D. Evans,J.B.

Murphy,2016-05-20 The supercontinent cycle hypothesis attributes planetary scale episodic tectonic events to an intrinsic self organizing mode of mantle convection governed by the buoyancy of continental lithosphere that resists subduction during the closure of old ocean basins and the consequent reorganization of mantle convection cells leading to the opening of new ocean basins Characteristic timescales of the cycle are typically 500 to 700 million years Proposed spatial patterns of cyclicity range from hemispheric introversion to antipodal extroversion to precisely between those end members orthoversion Advances in our understanding can arise from theoretical or numerical modelling primary data acquisition relevant to continental reconstructions and spatiotemporal correlations between plate kinematics geodynamic events and palaeoenvironmental history The palaeogeographic record of supercontinental tectonics on Earth is still under development The contributions in this Special Publication provide snapshots in time of these investigations and indicate that Earth s palaeogeographic record incorporates elements of all three end member spatial patterns **Proterozoic East Gondwana**

Masaru Yoshida,Brian F. Windley,Somnath Dasgupta,2003 This volume focuses on Late Mesoproterozoic to early Cambrian events related to Gondwana assembly and break up The nineteen papers provide a comprehensive review including advanced knowledge and new data from all critical areas of East Gondwana The recent knowledge of the evolution of East Gondwana which was regarded as an integral part of the Mesoproterozoic supercontinent Rodinia is the major theme of the volume which is reinforced by highlighting this radical and new understanding of the evolution of this region *Structural Geology and Tectonics Field Guidebook — Volume 1* Soumyajit Mukherjee,2021-03-22 This book helps a novice to explore the terrain independently Geoscience fieldwork with a focus on structural geology and tectonics has become more important in the last few years from both academic and industrial perspectives This book also works as a resource material for batches of students or geological survey professional undergoing training as parts of their course curriculum Industry persons on the other hand can get a first hand idea about what to expect in the field in case no academic person is available with the team This book focused on structural geology and tectonics compiles for the very first time terrains from several regions of the globe

Geomagnetism, Aeronomy and Space Weather Mioara Manda,Monika Korte,Andrew Yau,Eduard Petrovsky,2019-11-14 An interdisciplinary review of research in geomagnetism aeronomy and space weather written by eminent researchers from these fields Palaeomagnetic Applications in Hydrocarbon Exploration and Production Peter Turner,Amanda Turner,1995

Asian Geodynamics, Climate and Biodiversity G. Dupont-Nivet,T.N. Jonell,R. Dommain,P.D. Clift,2025-06-18 This book addresses the interplay between geodynamics climate and biodiversity focusing on the India Asia collision an ideal setting for studying interactive processes of Earth system sciences The rise of the Himalaya and Tibetan Plateau significantly influenced atmospheric circulation precipitation patterns and biotic evolution yet these interactive mechanisms remain topics

of debate New plate tectonic reconstructions combined with fossil records reveal plant and animal dispersal pathways and evolutionary patterns Climatic phenomena including monsoons and glaciations further influenced biodiversity by shaping habitats and driving speciation High altitude regions like the Hengduan Mountains became biodiversity cradles due to habitat heterogeneity and ecological niches Advances in palaeoaltimetry proxies molecular phylogenetics and climate and landscape modelling clarify the complex interactions between tectonics climate and biodiversity Asia s geological history offers insights into past climate biodiversity dynamics that are vital to understand current ecosystem responses to climate change This region s unparalleled biogeological activity makes it a focal point for Earth system science highlighting the need for interdisciplinary research to address global biodiversity and environmental challenges **Supercontinents,**

Orogenesis and Magmatism R.D. Nance,R.A. Strachan,C. Quesada,S. Lin,2024-04-24 This volume is a tribute to the career of J Brendan Murphy and features papers by over 100 authors from countries all over the world a testament to the high profile and far reaching influence of Brendan s work The topics covered fall into three broad categories that encompass Brendan s main fields of influence 1 supercontinents and the supercontinent cycle including reconstructions and modelling 2 orogenesis and terranes with a focus on the Appalachian Variscan and Central Asian orogenic belts and the oceans with which they are associated and 2 magmatism and magmatic processes centring on the geochemistry and isotopic compositions of magmas in arc and rift setting Like Brendan s own research the scope of the papers spans the globe and ranges from strongly field based studies to conceptual analyses All of the articles however are focused on unravelling some critical aspect of geology or aimed at clarifying some crucial geological process Hence they also share a theme common to Brendan s many contributions in emphasizing the importance of process oriented research **Continent Formation Through Time**

N.M.W. Roberts,M. van Kranendonk,S. Parman,S. Shirey,P.D. Clift ,2015-02-16 The continental crust is our archive of Earth history and the store of many natural resources however many key questions about its formation and evolution remain debated and unresolved What processes are involved in the formation differentiation and evolution of continental crust and how have these changed throughout Earth history How are plate tectonics the supercontinent cycle and mantle cooling linked with crustal evolution What are the rates of generation and destruction of the continental crust through time How representative is the preserved geological record A range of approaches are used to address these questions including field based studies petrology and geochemistry geophysical methods palaeomagnetism whole rock and accessory phase isotope chemistry and geochronology Case studies range from the Eoarchaeon to Phanerozoic and cover many different cratons and orogenic belts from across the continents *When Did Plate Tectonics Begin on Planet Earth?* Kent C. Condie,Victoria Pease,2008-01-01 Inspired by a GSA Penrose Conference held in Lander Wyoming June 14 18 2006 this volume discusses the beginning and evolution of plate tectonics on Earth and gives readers an introduction to some of the uncertainties and controversies related to the evolution of the planet In the first three sections of the book which cover isotopic geochemical

metamorphic mineralization and mantle geodynamic constraints a variety of papers address the question of when modern style plate tectonics began on planet Earth The next set of papers focuses on the geodynamic or geophysical constraints for the beginning of plate tectonics The volume s final section synthesizes a broad range of evidence from planetary analogues and geodynamic modeling to Earth s preserved geologic record This work provides an excellent graduate level text summarizing the current state of knowledge and will be of interest to a wide range of earth and planetary scientists Publisher s website

The Hidden History of Earth Expansion Stephen W. Hurrell,2020-05-14 For more than half a century the theory of continental drift was widely derided Innovators developing the radical theory were labelled as unscientific by well known science authorities But then in the space of a few years virtually all opposition dramatically collapsed Continental drift transformed into plate tectonics and became widely acknowledged as one of the most profound scientific revolutions of the twentieth century Yet a number of science innovators who had been closely involved with creating this new theory of the Earth continued to research an even more radical theory They saw evidence that the new geological theory was incomplete arguing that continental drift was caused by the Earth expanding in size These science innovators give us a unique insight into their experiences They relate their personal histories of Earth expansion in 14 original essays The Hidden History of Earth Expansion presents the unique personal histories of British American Australian German Polish Romanian Indian Albanian and Jamaican science innovators as they strived to produce a modern theory of the Earth It includes chapters expressly written for the book by some of the most well known researchers into Earth expansion Hugh G Owen Cliff Ollier Karl Heinz Jacob James Maxlow Jan Koziar Stefan Cwojdzinski Carl Strutinski Stephen W Hurrell John B Eichler William C Erickson David Noel Zahid A Khan Ram Chandra Tewari Vedat Shehu and Richard Guy In addition to furnishing us with their personal histories of Earth expansion and the seemingly overwhelming evidence for its confirmation the authors highlight areas where further research is required

Geomagnetic Field Variations in the Past E. Tema,A. Di Chiara,E. Herrero-Bervera,2020-10-15 In the last decades palaeomagnetic research has provided important information about the past variation of the Earth s magnetic field EMF from its origin to the present day However questions regarding the origin and evolution of the EMF as well as the frequency and spatial distribution of its variations still remain open to debate This Special Publication provides new insights into the study of the temporal and spatial evolution of the EMF presenting new data from palaeomagnetic and rock magnetic studies of archaeological materials sediments and lavas The papers presented cover a wide range of topics related to archaeology stratigraphy and climate including new data from several parts of the world such as Europe Africa Australia New Zealand India and the Baltic Sea This Special Publication aims to present an overview of the most recent secular variation studies and their use to disclose fundamental properties of the EMF evolution

Tectonic Development of the Eastern Mediterranean Region A. H. F. Robertson,Demosthenis Mountrakis,2006 The Eastern Mediterranean region is a classic area for the study of tectonic processes and settings related to the development of the

Tethyan orogenic belt The present set of research and synthesis papers by earth scientists from countries in this region and others provides an up to date interdisciplinary overview of the tectonic development of the Eastern Mediterranean region from Precambrian to Recent Key topics include continental rifting ophiolite genesis and emplacement continental collision extensional tectonics crustal exhumation and intra plate deformation e g active faulting Alternative tectonic reconstructions of the Tethyan orogen are presented and discussed with important implications for other regions of the world The book will be an essential source of information and interpretation for academic researchers geologists and geophysicists advanced undergraduates and also for industry professionals including those concerned with hydrocarbons minerals and geological hazards e g earthquakes

Deciphering Earth's History: the Practice of Stratigraphy Angela Coe, 2022-11-08 Stratigraphy allows us to establish and communicate the timings for the course of Earth history and provides the means to determine the duration and rates of Earth processes *Deciphering Earth's History: the Practice of Stratigraphy* focuses on how to apply the wide spectrum of stratigraphical techniques It also explains how these techniques can be integrated and details their individual strengths and limitations Chapters are laid out in a step by step style guiding the reader through a recommended approach and explaining the factors to be considered The methods are illustrated with flow charts marginal top tips checklists worked examples and over 200 figures Authors from academia research centres and industry have contributed to ensure a wide range of perspectives are included In addition to chapters on each of the stratigraphical techniques there is also material on accounting for stratigraphical incompleteness constructing geological timescales handling and archiving stratigraphical data and the application of stratigraphy to space exploration and other disciplines This book is designed for a wide audience ranging from advanced level undergraduates to professional practitioners wishing to use other stratigraphical techniques or understand the advantages and weaknesses of particular techniques

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