Celebrating our 5th year

On Track

The Newsletter of the International Fission-Track Community

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Editor: *Richard J. Weiland* and Assistant Editor: *Stefan S. Boettcher*
Department of Geological Sciences at the University of Texas at Austin, USA

In this Issue:

On Track is a biannual newsletter of the international fission-track community. It is printed in the months of May and November. The views expressed in *On Track* are those of the authors and do not necessarily reflect those of the fission-track community or the editor(s) of *On Track*.

On Track will remain free, at least for the near future. However, to save costs we generally mail only one copy per lab so please be sure to pass *On Track* around your lab.

Printing and mailing costs for this issue of *On Track* were paid for by a monetary donation from Donelick Analytical, Incorporated and paid advertisements. Full, half, and quarter page advertisements for this issue were purchased for US$ 200, US$ 100 and US$ 50, respectively. Contact the next editor for advertising prices in the next issue of *On Track* . There is no charge for "short" ads by non-commercial entities (e.g., universities). Send inquiries concerning this issue of *On Track* to the current editor. Send inquiries concerning the next issue of *On Track* to the next editor.

PREVIOUS EDITORS:

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Trevor Dumitru (1991-92), Stanford University
Rasoul B. Sorkhabi (1992-93)Arizona State University

Dennis Arne (1993-94) Dalhousie University

CURRENT EDITOR:

Richard J. Weiland (1994-95)
The University of Texas at Austin
Department of Geological Sciences
Austin, Texas 78712, United States
Tel.: 512-471-8547
Fax: 512-471-9425
E-mail: rweiland@maestro.geo.utexas.edu

NEXT EDITOR:

Ruth Siddell (1995-96)
Fission Track Research Group
Geological Sciences
University College London
Gower St.
London WC1E-6BT, United Kingdom
Tel.: 0171-380-7777 office ext. 2758, lab ext. 2418
Fax: 0171-388-7614,
E-mail: r.siddell@acl.ac.uk

Editors' Notes

Issue 10 of *On Track* marks the fifth year of the newsletter's existence, a testament to its worthiness! Nearly every month we received requests from people and groups who wished to be added to the directory and/or mailing list, an indication that *On Track* continues to bring important issues to the attention of the international fission-track (FT) community.

We at the University of Texas have enjoyed this opportunity to compile the FT news sent to us and distribute it back into the community. This publication continues to exist because of the contributions sent in by individuals.

In this issue **Peter Van den haute** and **Frans De Corte** make the first official announcement of the 8th International Workshop on Fission Track Dating. **Maria Balestrieri** and the Pisa FT group bring us up to date on the status of irradiating FT samples in Italy. **Dr. K. D. Bal** informs us of the progress made in India's new FT laboratory.

In response to the article on free FT software in issue 9 of *On Track*, **Kerry Gallagher** is offering a Macintosh based thermal modeling program named MONTE TRAX. This versatile program allows the user to choose between seven published FT annealing models and two probabilistic simulations based on real FT data. **David Coyle** introduces us to the concepts of object oriented programming and applications to thermal modeling of FT data. *On Track* is going electric! **Stefan Boettcher** has put issues 9 and 10 on the World Wide Web and is asking for input regarding the future of this new format. **Jon Linn** fills us in on his dissertation FT research in the Sevier belt of Central Utah.

Last but not least, we would like to introduce the next editor of *On Track,* **Ruth Siddell**. In 1994 she finished her dissertation entitled *Thermotectonic Evolution of the Bay of Biscay Continental Margins: A study using apatite fission-track analysis* under the tutelage of Dr. T. Hurford at University College London (UCL). Presently Ruth is employed as a lecturer at UCL. In her "spare time" she is conducting fission track thermochronologic research in the Massif Central (France) and the Cornubian Massif (United Kingdom), both Variscan (a.k.a. Hercynian) granitic massifs, and in the western Himalayas. These are collaborative research projects between the FT research groups at UCL and Royal Holloway and Bedford New College, University of London.

As the next editor of *On Track* Ruth will lead us into the newsletter's 6th year in print. Please make it as easy for her as it was for us by continuing to send in any and all news the FT community needs to know about.

Official Announcement of the 8th International Workshop on Fission-Track Dating

As was preliminarily announced at ICOG (Berkeley) and the SSNTD conference (Dubna), the next International Workshop on Fission-Track Dating will be held in

Gent, Belgium

The official workshop dates are

26-30 August, 1996

The Gent International Workshop has set as major ambitions to define the present status of the FT methodology and data interpretation and to identify future directions. >

Organization of the workshop is a collaborative effort of the Geological Institute (Peter Van den haute) and the Institute for Nuclear Sciences (Frans De Corte) of the University of Gent.

The first official circular will be sent off in June of this year. The eager and impatient can obtain more information by contacting us at the address, phone, facsimile, or e-mail numbers listed below.

8th International FT- Dating Workshop
Geological Institute, University of Gent
Krijgslaan, 28, B-9000 Gent, BELGIUM.

Phone: +32 (0) 9 264/ 4592 or 6627
Fax: +32 (0) 9 264 4984
E-mail: FTWORK@inwchem.rug.ac.be

A new irradiation facility for fission-track dating in the University of Pavia reactor

Maria Laura Balestrieri[(1)], Giulio Bigazzi[(2)] and Massimo Oddone[(3)]

[1] Dipartimento di Scienze della Terra, via S. Maria, 53, 56126 Pisa, Italy
[2] Istituto di Geocronologia e Geochimica Isotopica, CNR, via Cardinale Maffi, 36, 56127 Pisa, Italy
[3] Dipartimento di Chimica Generale, viale Taramelli, 12, 27100 Pavia, Italy

Other colleagues have very probably experienced disappointment caused by changes of characteristics of irradiation facilities or by closure of the reactor used systematically for the irradiations. This has occurred two times to the Pisa fission-track group: about 15 years ago the CAMEN 5 MW reactor (Pisa) stopped its activity, more recently, the best facility for fission-track dating available at the TRIGA Mark II reactor (0.25 MW) of the University of Pavia was made inaccessible by a long term physics experiment. We had to move to a less thermalized facility, called Lazy Susan (LS). This was unaffected by flux spatial gradients, but its thermalization is not ideal for fission-track dating (cadmiun ratio 6.4 for gold and 48 for cobalt).

Very recently the physics experiment finished, and it was possible to organize a new irradiation facility which is more satisfactory for fission-track dating, called thermal column (TC).

Irradiation tests showed the following characteristics:

Neutron flux. Au and Co monitors detected a thermal flux of 8.36 x 10^9 s^{-1} cm^{-2} and 8.40 x 10^9 s^{-1} cm^{-2}, respectively, in irradiation number P36, and a flux of 8.33 x 10^9 s^{-1} cm^{-2} (Au) and 8.48 x 10^9 s^{-1} cm^{-2} (Co) in irradiation number P37. Mean neutron fluences ([[Phi]]) determined by Au and Co foils in irradiations P36 and P37 (shown below) were in close agreement to those referred to the NIST SRM 962a glass standard when the average of the Cu and Au NIST calibrations was used.

[[Phi]] (Au, Co, P36) = 0.906 x 10^{15} cm^{-2}
[[Phi]] (962a, P36) = 0.924 x 10^{15} cm^{-2}
[[Phi]] (Au, Co, P37) = 1.041 x 10^{15} cm^{-2}
[[Phi]] (962a, P37) = 1.093 x 10^{15} cm^{-2}

Neutron thermalization. A cadmium ratio of 85.3 for gold and 643 for cobalt was determined in the TC facility. The induced track density measured on a volcanic glass sample (Monte Arci obsidian, Sardinia, Th/U ratio ~3) irradiated in the TC facility in a cadmium box was found to be reduced by a factor of 896.

Fluence spatial gradients. Au and Co foils did not detect spatial fluence gradients. These fluence values were determined 1 cm (1) and 6 cm (2) above the bottom:

Au(1): [[Phi]] = 0.904 x 10^{15} cm^{-2}
Au(2): [[Phi]] = 0.903 x 10^{15} cm^{-2}
Co(1): [[Phi]] = 0.906 x 10^{15} cm^{-2}
Co(2): [[Phi]] = 0.910 x 10^{15} cm^{-2}

Variation of induced track density in a 7 cm glass slide is shown in figure 1. Although a regression line suggests a gradient of about 0.7 % per cm, the correlation coefficient is very low (0.45). Track density seems to be very homogeneous in the region used for sample irradiation (between 0.5 cm and 5.5 cm above the bottom).

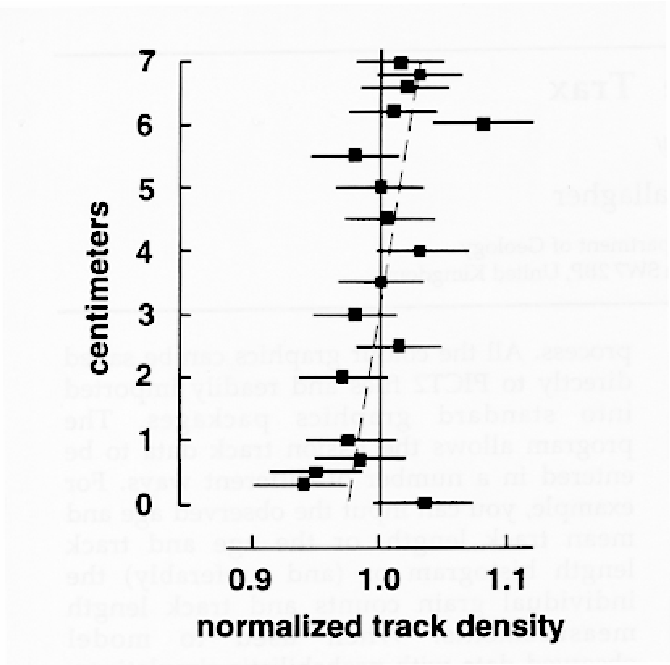


Figure 1. Normalized induced track density determined at different height above the bottom in a glass slide irradiated in the thermal column (TC) position.

Ages determined on age standards (or putative age standards) were found to agree with expected ages:

Fish Canyon Tuff apatite, determined age 27.5 +/- 1.4 Ma ($^{40}Ar/^{39}Ar$ age 27.8 +/- 0.2 Ma); Moldavite glass, determined age 15.2 +/- 0.8 Ma (K-Ar age 15.17 +/- 0.15 Ma); Macusanite glass, determined plateau age 6.07 +/- 0.25 Ma (K-Ar age 5.67 +/- 0.10 Ma); Jas G1 obsidian, determined plateau age 0.97 +/- 0.06 Ma ($^{40}Ar/^{39}Ar$ age 0.945 +/- 0.005 Ma).

The TC facility appears very suitable for fission-track dating. Due to the low thermal neutron flux relatively long irradiation times are needed for the fluences requested by the fission-track dating method. However, the TC facility is relatively free, so week-long irradiations do not represent a problem.

Acknowledgments

We wish to thank Dr. V. De Michele, Dr. C. W. Naeser, Dr. G. Poupeau, Dr. Wadatsumi and N. Kitada for providing test samples.

A New Track on the Horizon

K. D. Bal
KDM Institute of Petroleum Exploration
Oil & Nat. Gas Corporation Ltd., Dehradun, India

In an attempt to bring additional tools to petroleum exploration in India, **Dr. M. Lal, Dr. K. D. Bal,** and **R. S. Waraich** have set up a fission-track (FT) laboratory at the KDM Institute of Petroleum Exploration (KDMIPE). KDMIPE is the premier R&D institute of the Oil & Natural Gas Corporation Ltd. (ONGC), the single largest petroleum co. in India.

India has a large number of petroliferous sedimentary basins. The ONGC envisions that the FT laboratory's research will concentrate on quantitative modeling of the thermal histories of India's sedimentary basins and characterization of their associated hydrocarbon reservoirs. Vitrinite reflectance has been the main parameter used for thermal history modeling by the ONGC. The ONGC`s only attempt to generate FT data has been in the Ganga Basin. Considering the merits of the FT method, we see a great opportunity to carry out FT studies throughout sedimentary basins in India. Preliminary studies have begun to identify critical basins and bore-holes for evaluation.

At this time all equipment including an automated microscope stage system has been installed in the laboritory. Dr. Bal and R. Waraich are now standardizing laboratory and counting procedures. Unfortunately, Dr. Lal has been reassigned within KDMIPE after playing a lead role over the past three years.

We take this opportunity to convey our sincere thanks to **Dr. C. W. Naeser** and **Dr. A. J. Hurford** for providing age standards, **Dr. D. S. Miller** for providing "unknown" samples for calibration, and **Dr. J. Schreurs** for providing CN glass dosimeters. Finally, we thank **Dr. N. Lal** and **Dr. K. K. Sharma** for their guidance and lectures on current uses of the FT method in petroleum exploration.

Monte Trax

Kerry Gallagher
Imperial College, Department of Geology
Prince Consort Road, London SW7 2BP, United Kimgdom

WHAT IS MONTE TRAX ?

Monte Trax is a Macintosh program which can be used to :
(i) calculate fission track parameters (age and length distribution) for a specified thermal history
(ii) constrain the range of thermal histories consistent with observed fission track parameters

HOW DOES IT WORK ?

Monte Trax allows a user to specify a thermal history (as a series of time:temperature points) and calculate fission track parameters (FT age and length distribution) using one of a possible 7 published models for track annealing. This is referred to as the forward calculation, or solving the forward problem, and, in general, will be run once for a given thermal history. Alternatively, the user may input observed fission track parameters and specify bounds on possible time and temperature values. A probabilistic approach (either random Monte Carlo or Genetic Algorithm) is used to select time-temperature points from within these bounds and construct a thermal history. The predicted fission track parameters are then quantitatively compared to the observed values, and the level of agreement between the two is used to assess the thermal histories most consistent with the observed data.

IS IT USER FRIENDLY ?

It is very straightforward to use, incorporating the usual Macintosh pull down menus, dialog boxes, etc. to allow a user to interact easily with the input and data manipulation process. All the colour graphics can be saved directly to PICT2 files and readily imported into standard graphics packages. The program allows the fission track data to be entered in a number of different ways. For example, you can input the observed age and mean track length, or the age and track length histogram or (and preferably) the individual grain counts and track length measurements. When used to model observed data with probabilistic simulations, the user has the capability of selecting individual thermal histories, or a group of thermal histories that predict the observed fission track data to a user specified tolerance. A variety of built in statistical tests determine how well individual thermal histories fit the observed data. Finally, the program comes with extensive documentation and example data files.

WHAT DOES IT RUN ON ?

The program will run on the 68K Macintoshes (those with 68020/30/40 processor and the 68881/2 math coprocessor and also on the LC models with 13" screens, provided a math coprocessor has been installed). There is also a native version for the PowerMacs. These are generally faster than the 68K machines. As yet a Fat Binary (a single application to run on both the 68K and PowerMac machines) is not available.

HOW CAN I GET IT ?

It's not yet available in the High Street or nearest Mall. Contact Kerry Gallagher via e- mail: kerry@ic.ac.uk or the address listed above for details.

Annealing, Objects, and Distributed Computing

David A. Coyle
Max Plank Institut-Kernphysik, Heidelberg, Germany

This short article is to inform you all about the current project that I am working on, in addition to the KTB *in situ* annealing studies. It has to do with finding a way to run random or directed search thermal history programs, in a way that is a) easy, b) cheap, and c) allows arbitrary (high) precision. How the time-temperature space is sampled is not important for this discussion, so if you're a fan of Genetic Algorithms, Neural Networks, or just plain old Monte Carlo searches, there's still something here for you.

My approach is to use objects. Oh, not just any objects, like the screen-painted buttons that Visual Basic gives you. No, I mean real objects, using a completely object-oriented operating system, and Objective-C (unlike C++, Obj-C allows *run-time binding*.). I was once asked "What's the difference between an object and a subroutine?" I think that this article should make that clear, but first and foremost, an object has a "life" of it's own. It does not need to exist in the context of a larger program, and it does not need to go away when that program terminates. But it is also not a program on its own, mainly because it does not have its own event loop. An object exists, and performs actions in response to messages that it receives from other objects. A secretary, sitting in her office, won't (necessarily) be doing anything until the phone rings, the intercom buzzes, the boss calls her in for dictation, whatever. The secretary is a self-contained entity and can be picked up and placed in another office, and begin to work immediately. She can also respond to different messages, and take the appropriate action. Subroutines, on the other hand, have only one entry point, and can perform only limited actions with limited data. A subroutine is more like the government, only doing one thing: taking your money, and spending it.

So how do objects fit into annealing? The basic plan for my object system is shown in figure 1.

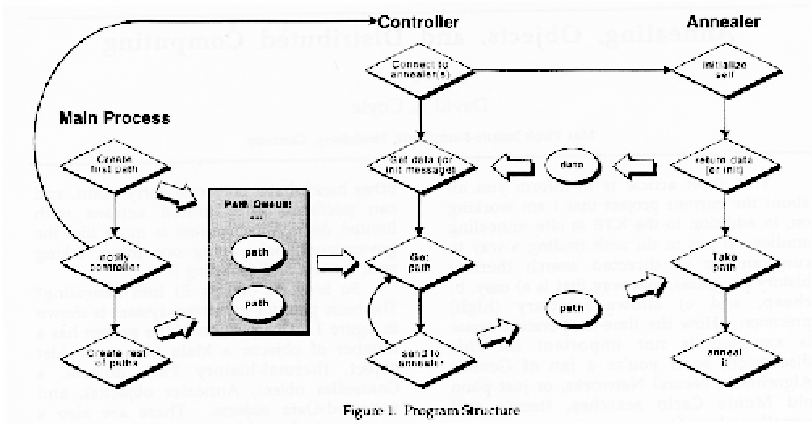


Figure 1. Program Structure

This portion of the system has a number of objects: a Main process, a List object, thermal-history Path objects, a Controller object, Annealer object(s), and annealed-Data objects. There are also a number of other objects not shown, but they are not important right now. The important thing to note is that data are not variables, they are totally separated from the processes. This is an important abstraction, because as one follows the system, one sees that the various procedure objects do not need to keep the data any longer than they operate on it. Once the Annealer is finished annealing the path, it includes the path with the calculated parameters and sends it back to the Controller. The data itself is never copied, it is passed from process to process, as needed. Thus there is no need to keep track of numerous arrays, for example. More importantly there is no need to make sure that one frees the arrays when done with them.

Let's follow a path through the system, to see what happens to it. First, the main Process creates a time-temperature Path object. It then shifts that object into a Queue. The Process now does not own the path, nor does it retain any reference to it. Next, the Process informs the Controller that there is data in the queue, and goes on to create more paths, using Monte Carlo, GA, etc. The Controller, being in a separate *thread* (an independent process), can now act on its own. It consults its list of available Annealer objects, and connects to them. Once connected, the Controller takes a path out of the queue, and passes it to the next available Annealer, which is also in its own thread. The Annealer anneals it, and passes the path plus the data back to the Controller. The Controller (or another object) evaluates the data, and either eliminates the object, if the data is not useful, or archives it. Then the Controller takes another path from the queue, and passes this to the now-idle Annealer. And so on, until all paths have been processed. The important part is that the Controller does not need to know which Annealer is doing what. When any Annealer is finished, it contacts the Controller. So, for example, if there are two Annealer objects, one on a fast machine, and one on a slow machine, the fast machine may get two paths annealed for every one that the other machine processes, but the Controller never waits for the response from a specific Annealer: any Annealer will do. So how does distributed computing fit into the picture? Well, that is shown in figure 2.

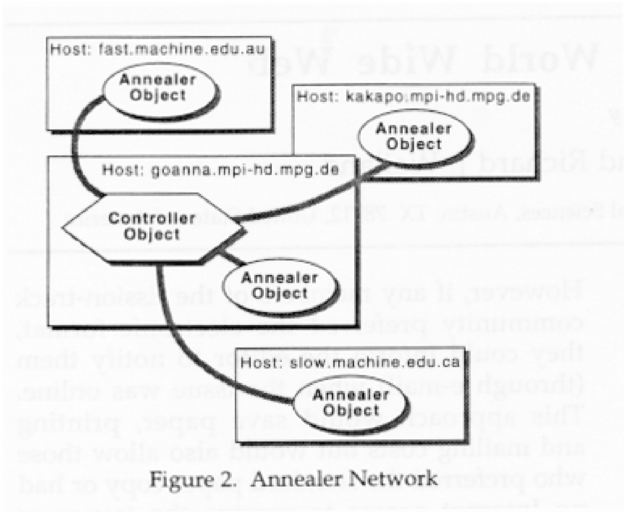


Figure 2. Annealer Network

Because the Annealer objects are independent of the Controller, there is in fact no requirement that they be a) compiled into this program, and b) on the same computer, or c) even on the local network. By splitting the problem and distributing it around, we are now able to evaluate thermal histories with a precision like never before. We can do searches with not just the measly tens of tracks/timesteps and hundreds of paths that are common to current programs, but with thousands, or tens of thousands. At the very least, we can routinely track the number of fission-tracks that are actually measured in the samples, be it 500, or 1500. I've tested the Annealer object with up to 10,000 tracks/ timesteps: it's slow, but it works. And this is on a machine that's not much faster than a Pentium. If I could place the Annealer on a DEC Alpha workstation (Portable Distributed Objects run on DEC OSF/1), then it'd be pretty zippy, even at that resolution. Of course, you have lots of questions:

Q: Isn't this distributed object stuff hard? Connecting to a remote object, across the Internet, yikes!

A: You couldn't be further from the truth.
I said at the beginning that I'm using a real object-oriented system. Here is the procedure for connecting to a remote object. From the remote object side, we just need to include these methods: myConnection = [NXConnection registerRoot:self withName: REGISTERED_NAME]; [myConnection run]. For an Annealer object, we would make the registered name ANNEALER. From the controller side, we need to implement these two methods: server = [NXConnection connect-ToName: REGISTERED_ NAME onHost:"machine.site.edu"]; myConnection = [server connectionForProxy]; You now send messages to the remote object through this proxy: [myConnection doSomething]; The only real constraint is that the remote object must make itself available first, but that's easily accomplished using a daemon process that starts when the machine is booted.

Q: But naturally this is prohibitively expensive for us mere mortals...

A: Well, the US price for the NextStep Academic Bundle (on 2 CD-ROMs) is $300, which includes everything, especially the develop-ment tools. And, NextStep will run on most hardware platforms: Intel, Hewlett-Packard PA-RISC workstations, Sun SPARC work-stations, and good ol' NeXT "slabs" and "cubes". The system independent version, OpenStep, will run this year on Solaris, OSF/1, WindowsNT & 95, and also a free version, the "GnuStep" is being created that will run on any other UNIX system (Linux, HP-UX...). PDO for foreign operating systems is more expensive, though.

Q: This is just a concept: it's not real, is it?

A: Well, the Annealer object exists already: I use it all the time, and the controller object is just an accountant that could be written and debugged in a day or two. The real constraint is the engine that creates the temperature-time paths, because we want to make different engines and evaluators *dynamically loadable*: able to be attached to the program without recompiling. I'm working on a graphic interface for constraining the paths in *t-T* space right now (where you draw boxes in a view). For that the icon, the cursors, and mouse-driven events are near-complete, and only the drawing code and the actual path generator need to be coded. ***If*** I can get two weeks of solid programming time, then this will all be ready (that is a big "if", by the way). Of course, if you want to help, it will be ready sooner. In any case, it should be real by the time of the next FT Workshop, because I would like to demo it there.

So, you see, real computing isn't that hard, nor is it necessarily expensive. One of the things that I like about the NextStep operating system is that it scales upwards. Most power-users of DOS or Macs are frustrated, because they usually already have the fastest machines they can get. Machines that run NextStep *start* at the Pentium level, and only get (much!) faster (I've actually got the *slowest* Hewlett-Packard workstation that they make). So you can test a concept cheaply on a Pentium: when you see that it works, and that you need more speed, you can just buy a faster machine. If your program runs on DOS or Mac and you want a faster machine, well, you're in trouble, because either you just have to wait, or if you switch to a workstation, most (more likely all) of your program will need to be rewritten.

On Track and the World Wide Web

Stefan S. Boettcher and Richard J. Weiland
University of Texas at Austin, Department of Geological Sciences, Austin, TX 78712, United States of America

After completing the last two issues of *On Track* (numbers 9 and 10), we decided to follow the suggestion of John Garver (Union College, New York) and make the issues available through the University of Texas Geology Library home page on the World Wide Web. The URL (Universal Resource Locator) address for the University of Texas Geology Library home page is URL = `**http://www.lib.utexas.edu/Libs/GEO/geology.html**'. Issue number 9 of *On Track* can be accessed from this site by scrolling down the page and clicking on the underlined "full text of the current newsletter". After issue number 10 is released, we will update the entry to indicate the availability of both issue 9 and issue 10 online. The html (hypertext markup language) format was created by first opening Microsoft Word 5.1 and saving the document as an rtf (rich text format) file. Next, rtftohtml-mac software was used to automatically create the html file. At this point, manual editing (by Jim McCulloch, Univ. of Texas Librarian) was required to arrive at the final format as the automated rtftohtml-mac software as not able to reproduce all the formatting we desired. The entire process took about 3 hours to accomplish.

We consider the WWW format to be experimental and are eager to hear feedback regarding the style, potential problems, and role the electronic format should have in distributions of future issues. Our first inclination was to have the electronic format serve as an effective archiving site for back issues of *On Track*. In this way, new practitioners and scientists outside of the international fission-track community could easily access both new and old issues.

However, if any members of the fission-track community preferred the electronic format, they could inform the editor to notify them (through e-mail) when the issue was online. This approach would save paper, printing and mailing costs but would also allow those who preferred the standard paper copy or had no Internet access to receive the issues as usual. Furthermore, the html format would be platform independent, allowing Mac, DOS, and UNIX users to access the document without regard to system compatibility.

In our discussions with previous editors, a number of issues have arisen concerning preparation of electronic versions of back issues of *On Track*. A common concern was that hard copies of previous issues contained illustrations and/or photos that were glued on to paper before the whole issue was sent off for printing. Thus, no computer version of the illustrations are available to facilitate conversion to the GIF (graphics interchange format) images necessary for accessibility by web browsers. GIF images have no particular format, they are just byte representations of the image, one to four bytes or so per pixel. We were able to quickly overcome this problem for the cartoon on page 6 of issue number 9 by scanning the figure, then saving it as a GIF image in Adobe Photoshop^{TM}. Advertisements pose a greater problem, as special fonts or border designs may not be compatible with GIF images (there are no fonts in GIF files, just the image). In issue 9, we had to simplify the border designs of one advertisement because of this problem.

Aside from these relatively minor technical difficulties, a more serious issue involving web availability involves *On Track* articles that may have been superseded by more up to date journal articles. Authors could, however, ask editors to establish links to the newer publication and leave the old one for historical purposes. Copyright laws will be an issue only if the journal article and the *On Track* article are identical. In any case, it is important for the fission-track community to be aware of the issues involved with the electronic medium and to provide feedback before a commitment is made to make all issues available on the World Wide Web.

Because we are passing on our editorial responsibilities after this issue, we will let the next editor decide whether or not they wish to continue with the electronic format. If previous and future editors do decide to make *On Track* issues available online, we believe that it is best for individual editors to do the html formatting, provide an access site (server), and establish links to other sites where *On Track* issues are available for the public. However, if past editors would rather not undertake such an endeavor, we are willing to do html formatting during the next year (1995-1996). Please address any comments regarding the pros and cons of *On Track* online availability to:

Stefan S. Boettcher
Assistant Editor of *On Track* (1994-1995)
Dept. of Geological Sciences, University of Texas at Austin
Austin, TX 78712

or via E-mail: sboett@maestro.geo.utexas.edu

Short Tracks: News

Ed Sobel has finished his Stanford Ph.D. and moved to France. Look for a paper in Tectonics later this year regarding his work on Himalayan exhumation around the margins of the Tarim Basin in western China. Ed has a post-doc with argonist Nick Arnaud at the University of Clermont-Ferrand. He collected FT samples from the Altyn Tagh fault on the northern boundary of Tibet last summer, and if they ever emerge from the shipping maze, will work on them in Diane Seward's lab at E.T.H.-Zürich.

Trevor Dumitru, **Elizabeth Miller**, and **Roland Bürgmann** (Stanford) recently had two N.S.F. grants funded, one for Basin and Range extension in Utah, Nevada, and California, and one for neotectonics and seismic hazards along the San Andreas fault system around San Francisco. **Danny Stockli** will work on the Basin and Range project as part of his Stanford Ph.D. Danny is now finished with his master's degree at E.T.H.-Zürich. Repair of the Stanford Geology Corner, closed by the 1989 earthquake, is now underway, and parts of the FT set-up will move to this beautiful old building in about a year.

Although now stationed at the University of Texas at Austin, **Pete George** continues the post doctorate work he started at the University of Wyoming. Pete is dating and measuring track lengths in apatite from Paleocene conglomerates of the Hanna Fm. in the Hanna Basin of Wyoming. The ages are roughly equivalent to their depositional ages. Mean track lengths range between 13.4 and 14.1 um indicating the apatite have been partially annealed. The source area for these arkosic strata (a section ~3 m thick) is probably the Granite Mtns. to the northwest. One possible explanation of these data is rapid exhumation and erosion of the source area in Late Pliocene time and subsequent transport and burial in the northwestern part of the Hanna Basin. Partial annealing is assumed to have occurred during burial in Late Pliocene-Early Eocene time. Soon thereafter, these rocks were probably folded, uplifted, and exumed along the Shirley Thrust in Wasatchian time. Future work on this project will include the dating of samples from the Granite Mtns. and a lithologic/mineralogic comparison between matrix and clasts from the Hanna Fm. and Precambrian rocks in the Granite Mtns.

Timing and thermal characteristics of Sevier belt thrust faulting and synorogenic sedimentation in the Pavant and Canyon Ranges, central Utah

Jon Linn
University of Kansas, Department of Geology, 120 Lindley Hall, Lawrence, KS 66045, United States of America

Purpose of Project:

The complexity of the Sevier orogenic belt in central Utah has left many details about its structural and sedimentological development unresolved. Specifically, the ages of the Pavant and Canyon Range thrusts and details of synorogenic sedimentation in central Utah are debatable (e.g., Lawton, 1985; Villien and Kligfield, 1986; Royse, 1993). Also, the thermal evolution of the Pavant and Canyon Range thrust sheets has not been addressed. Apatite and zircon fission-track analyses are being conducted on the Neoproterozoic Mutual Formation and the Lower Cambrian Tintic Quartzite from the Pavant and Canyon Range thrust sheets and clasts of these quartzites in synorogenic sequences to resolve these problems.

Implementation of fission-track analysis for this study relies on the resetting of the apatite and zircon fission-track clocks by burial and heating of the Mutual Formation and Tintic Quartzite at the base of the thrust sheets prior to thrust faulting. As thrust faulting uplifted the quartzite, erosion resulting in cooling of the thrust front below the zircon and apatite retention temp-eratures. Thus fission-track ages from the quartzites yield indirect information about the timing of thrust faulting and presumably the thermal evolution of the thrust sheet during and after thrusting. Quartzite clasts in synorogenic conglomerates should have undergone similar thermal histories as the quartzite units from which there were derived, so fission-track analysis will be used to place additional constraints on the timing of thrust sheet motion and unroofing.

Results of this project will increase our knowledge about the tectonic development of a part of the Sevier orogenic belt that, at the present time, is not well-constrained. Also, this project will demonstrate that fission-track analysis can be used to constrain the timing of motion of thrust faults and the timing relationships between synorogenic sedimentary rocks and thrust faults in areas where structural reconstructions and sedi-mentological relationships are debatable. Moreover, by using fission-track analysis to constrain the relative ages of the Pavant and Canyon Range thrusts, I hope to show that the technique can be a reliable method for constraining the sequence of thrust development (i.e., forward-breaking vs. backward-breaking).

Results to Date:

Apatite fission-track analysis has been conducted on seventeen quartzite samples from the Pavant and Canyon Range thrust sheets and conglomerates from the Pavant Range and Canyon Range, central Utah. Several important points can be made from the data thus far: 1) Compositional effects play an important role in the single grain fission-track ages in these samples. For each sample, the pooled age for F-Cl-OH apatite is typically older than the pooled age for F-apatite. This is consistent with the FT work being done by Ray Donelick in an adjacent area (see Burtner et al., 1994 for methodology; U.S. Patent Number 5,267,274 to Raymond A. Donelick). 2) Data from quartzite samples collected from the Pavant thrust sheet indicate that it cooled below 130-140[[ring]]C (approximate retention temperature range for Cl-apatite) and 100-110[[ring]]C (approximate retention temperature range for F-apatite) around 60-70 Ma and 40-50 Ma, respectively. Zircon fission-track analysis and thermal modeling are required to assess the relationship between these ages and the actual timing of motion on the Pavant thrust fault. 3) All quartzite samples from the central Canyon Range yielded Miocene fission-track ages. It is unclear at the present time whether these ages represent slow erosional unroofing of the thrust sheet or a younger thermal overprint not related to Sevier belt thrusting (such as Basin and Range tectonism). 4) Fission-track ages from most of the conglomerates fall into two groups. The first group shows F-apatite fission-track ages of around 50 Ma and F-Cl-OH apatite ages of around 70 Ma. The second group shows F-apatite fission-track ages of around 70 Ma and F-Cl-OH apatite ages around 90 Ma. Both groups are represented by conglomerate samples from the Pavant Range and the Canyon Range, so more data is required to assess the tectonic implications of these data. 5) Only two samples yielded enough apatite grains to obtain at least 40 horizontal confined track length measurements. Both samples are from the Pavant thrust sheet and yielded mean track lengths of 11.6+/-2.2 mm (n=55) and 12.8+/-2.4 mm (n=47). Thermal modeling has not yet been conducted on either of these samples.

Future Work:

Future work includes zircon fission-track analysis on all samples which will further constrain the timing of thrust faulting, the maximum temperature the base of the thrust sheets reached prior to thrust faulting, and the overall cooling rate of the thrust sheets as they were uplifted and eroded. Further sample collection is required as well. Sampling will concentrate on the Canyon Range thrust sheet, which has produced the most complex results in the first round of analyses. Quartzite from the Pavant thrust sheet and conglomerates from both ranges will also be collected in order to build a more robust data set.

References Cited:

Burtner, R. L., Nigrini, A., and Donelick, R. A., 1994, Thermochronology of Lower Cretaceous source rocks in the Idaho-Wyoming thrust belt: AAPG Bulletin, v. 78, p. 1613-1636.

Lawton, T. F., 1985, Style and timing of frontal structures, thrust belt, central Utah: AAPG Bulletin, v. 69, p. 1145-1159.

Royse, Jr., F., 1993, Case of the phantom foredeep: Early Cretaceous in west-central Utah: Geology, v. 21, p. 133-136.

Villien, A. and Kligfield, R. M., 1986, Thrusting and synorogenic sedimentation in central Utah, *in* Peterson, J. A., ed., Paleotectonics and Sedimentation: Tulsa, OK, AAPG Memoir 41, p. 281-307.

Recent Fission-Track Papers

Please send items for future listings in *On Track* to the next editor, Ruth Siddell. The reference or a photo copy of the first page will suffice but a copy of the entire paper is appreciated. We especially want non-fission-track papers that may be of special interest to the fission-track community. Papers in press are welcome, please include an estimate of the expected month of publication. A special thanks to Trevor Dumitru for providing most of the references listed below.

Alloway, B. A., Westgate, J. A., and Pillans, B., 1994, Revision of the Plio-Pleistocene marine chronology in New Zealand: *Geological Society of America Abstracts with Programs*, v. 26, n. 7, p. 258.

Arehart, G. B., Foland, K. A., Naeser, C. W., and Kesler, S. E., 1995, ^{40}Ar/^{39}Ar, K/Ar, and fission-track geochronology of sediment-hosted disseminated gold deposits at Post-Betze, Carlin Trend, northeastern Nevada [reply]: Economic Geology, v. 90, p. 210-212.

Armstrong, P. A., Chapman, D. S., Funnell, R. H., Allis, R. G., and Kamp, P. J., 1994, Thermal modeling and hydrocarbon generation in an active margin basin, the Taranaki Basin, New Zealand: *American Association of Petroleum Geologists Annual Meeting Abstracts,* 12-15 June 1994, Denver Colorado USA, v. 1994, p. 95.

Arne, D. C., 1994, Phanerozoic exhumation history of northern Prince Charles Mountains (East Antarctica): *Antarctic Science*, v. 6, p. 69-84.

Black, T. M., Shane, P. A. R., and Westgate, J. A.,, 1994, Late Quaternary ignimbrite stratigraphy in New Zealand as revealed by isothermal plateau fission track ages and paleomagnetism: *Geological Society of America Abstracts with Programs*, v. 26, n. 7, p. 258.

Blythe, A. E., and Kleinspehn, K. L., 1994, Apatite and zircon fission-track evidence for Eocene cooling of Spitsbergen and the Barents Shelf: *Geological Society of America Abstracts with Programs*, v. 26, n. 7, p. 198.

Blythe, A. E., and Patrick, B. E., 1994, Tertiary cooling and deformation in the south-central Brooks Range, Alaska, deduced from apatite fission track analyses: *Geological Society of America Abstracts with Programs*, v. 26, n. 2, p. 39.

Brandon, M. T., and Pazzaglia, F. J., 1994, Late Quaternary deformation of fluvial terraces at the Cascadia convergent margin, Northwest Washington State: *Geological Society of America Abstracts with Programs*, v. 26, n. 7, p. 524.

Broquet, P., Chambaudet, A., Charlet, J. M., and Rebetez, M., 1994, Empreintes laissees par la radioactivite naturelle dans les materiaux geologiques, traces de fission de l'uranium et thermoluminescence appliquees aux sciences de la terre [Imprints left by natural radioactivity in geologic materials; uranium fission tracks and

thermoluminescence applied to earth science]: *Memoires de la Societe Geologique de France Nouvelle Serie,* n. 162, p. 87-98.

Brown, R., Gallagher, K., and Duane, M., 1994, A quantitative assessment of the effects of magmatism on the thermal history of the Karoo sedimentary sequence: *Journal of African Earth Sciences,* v. 18, p. 227-243.

Burbank, D., Leland, J., Reid, M., Anderson, R., Caffee, M., and Finkel, R., 1994, Bedrock incision and uplift rates along the Indus River, N. Pakistan: *Geological Society of America Abstracts with Programs*, v. 26, n. 7, p. 208.

Clendenen, W. S., Pevear, D. R., Tapscott, C. R., James, Wi. R., and Kim, C. S., 1994, Integrated paleothermometry, reconstructing the thermal history of sedimentary basins: *American Asso-ciation of Petroleum Geologists Annual Meeting Abstracts,* p. 122.

Cloos, M., McMahon, T. P., Quarles Van Ufford, A., Sapiie, B., Warren, P. Q., and Weiland, R. J., 1994, Collisional delamination in New Guinea: *Geological Society of America Abstracts with Programs*, v. 26, n. 7, p. 502.

Cook, A. C., Duddy, I., and Green, P., 1994, Measurement of vitrinite reflectance and its use with temperatures based on apatite fission track analysis (AFTATM): *American Association of Petroleum Geologists Annual Meeting Abstracts,* p. 125.

Cullen, P. J., Wright, S. C., Kearney, C. J., and Pink, A. T., 1994, Exploration in the Savannakhet Basin, Peoples Democratic Republic of Laos: *American Association of Petroleum Geologists Bulletin*, v. 78, p. 1139.

Cunningham, C. G., Naeser, C. W., Marvin, R. F., Luedke, R. G., and Wallace, A. R., 1994, Ages of selected intrusive rocks and associated ore deposits in the Colorado mineral belt: *U. S. Geological Survey Bulletin* 2109.

Davison, I., Al-Kadasi, M., Al-Khirbash, S., Al-Subbary, A. K., Baker, J., Blakey, S., Bosence, D., Dart, C., Heaton, R., McClay, K., Menzies, M., Nichols, G., Owen, L., and Yelland, A., 1994, Geological evolution of the southeastern Red Sea Rift margin, Republic of Yemen: *Geological Society of America Bulletin*, v. 106, p. 1474-1493.

Demis, W. D., 1994, Effect of cross-basinal hydrodynamic flow on oil migration and accumulations in Bakken-Madison (Mississ-ippian) petroleum system, Williston Basin, North America: *American Association of Petroleum Geologists Annual Meeting Abstracts,* p. 135-136.

Donelick, R. A., and Corigan, J., 1994, Apatite fission track analysis applied to margins of the Gulf Coast Basin: *Houston Geological Society Bulletin,* v. 36, p. 11.

Doré, A. G., Augustson, J. H., Hermanrun, C., Stewart, D. J., and Sylta, Ø., eds. Basin Modeling: Advances and Applications, Proceedings of the Norwegian Petroleum Society Confrence, 13-15 March 1991, Stavanger, Norway: *Norwegian Petroleum Society (Norsk Petroleums-forening / NPF) Special Publication No.* 3, Elsevier, Amsterdam, 675 p.

Dumitru, T.A., E.L. Miller, P.B. O'Sullivan, J.M. Amato, K.A. Hannula, A.C. Calvert, and P.B. Gans, 1995, Cretaceous to Recent extension in the Bering Strait region, Alaska: Tectonics, vol. 14, in press, June(?) issue.

Elliott, W. C., Roden, M. K., and Aronson, J. L., 1994, Apatite and zircon fission track ages for Late Cretaceous bentonites along the Front Range, Denver Basin, Colorado: *Geological Society of America Abstracts with Programs,* v. 26, n. 7, p. 230.

Fayon, A. K., Peacock, S. M., and Stump, E., 1994, Dating extensional deformation using apatite fission-track thermochronology and thermal modeling: *Geological Society of America Abstracts with Programs,* v. 26, n. 7, p. 467.

Feng, Z., Johnson, W. C., Lu Y., and Ward, P. A., III, 1994, Climatic signals from loess-soil sequences in the central Great Plains,USA: *Palaeogeography, Palaeoclimatology, Palaeoecology,* v. 110, p. 345-358.

Gansey, S. S., and Pletnev, S. P., 1992, Pliocene-Pleistocene boundary in Japan Sea (Site 299 DSDP): *29th International Geological Congress Abstracts*, v. 29, p. 269.

Green, P. F., Duddy, I. R., and Bray, R. J., 1995, Further discussion on Mesozoic cover over northern England; interpretation of apatite fission track data: *Journal of the Geological Society [of London]*, v. 152, p. 416.

Hannula, K. A., Miller, E. L., Dumitru, T. A., Lee, J., and Rubin, C. M., 1995, Structural and metamorphic relations in the southwestern Seward Peninsula, Alaska: Crustal extension and unroofing of blueschists: Geological Society of America Bulletin, v. 107, p. 536-553.

Hasebe, N., Tagami, T., and Nishimura, S., 1994, Towards zircon fission-track thermochronology, reference framework for confined track length measurements: *Chemical Geology,* v. 112, p. 169-178.

Hooghiemstra, H., and Melice, J. L., 1994, Pleistocene evolution of orbital periodicities in the high-resolution pollen record Funza I, Eastern Cordillera, Colombia" de Boer, P. L., et al.: *International Association of Sedimentologists Special Pub-lication No.* 19, p. 117-126.

Hooghiemstra, H., and Ran, E. T. H., 1994, Late and middle Pleistocene climatic change and forest development in Colombia, pollen record Funza II (2-158 m core interval): *Palaeogeography, Palaeo-climatology, Palaeoecology*, v. 109, p. 211-246.

Horn, P., Mueller-Sohnius, D., Storzer, D., and Zoeller, L., 1993, K-Ar-, fission-track-, and thermolum-inescence ages of Quaternary volcanic tuffs and their bearing on Acheulian artifacts from Bori, Kukdi Valley, Pune District, India: *Zeitschrift der Deutschen Geologischen Gesellschaft*, v. 144, p. 326-329.

Houghton, B.F., C.J.N. Wilson, M.O. McWilliams, M.A. Lanphere, S.D. Weaver, R.M. Briggs, and M.S. Pringle, 1995, Chronology and dynamics of a large silicic magmatic system: Central Taupo volcanic zone, New Zealand, Geology, v. 23, p. 13-16.

Ilchnik, R. P., 1995, $^{40}Ar/^{39}Ar$, K/Ar, and fission track geochronology of sediment-hosted disseminated gold deposits at Post-Betze, Carlin Trend, northeastern Nevada [discussion]: Economic Geology, v. 90, p. 208-210.

Jansen, J. C., and Archibald, D. A., 1994, Cretaceous-to-Paleogene tectonothermal evolution of the Purcell Anticlinorium, SE B.C., from $^{40}Ar/^{39}Ar$ dating of K-feldspar and mica: *Geological Society of America Abstracts with Programs,* v. 26, n. 7, p. 195.

John, B. E., 1994, Cataclastic rocks associated with extreme crustal extension, southern Basin and Range, evidence for paleoseismicity along low-angle normal fault?: *U.S. Geological Survey Open-File Report* 94-0568, p. 86-87.

Kelley, S. A., and Chapin, C. E., 1994, Cooling histories along the High Plains-Southern Rocky Mountains boundary as deduced from apatite fission-track thermochronology: *American Association of Petroleum Geologists Annual Meeting Abstracts,* p. 186.

Khan, H. A., and Qureshi, A. A., 1994, Solid state nuclear track detection, a useful geological/ geophysical tool: *Nuclear Geophysic*s, v. 8, p. 1-37.

Koeberl, C., Storzer, D., and Reimolds, W. U., 1994, The age of the Saltpan impact crater, South Africa: *Meteoritics*, v. 29, p. 374-379.

Landis, C. R., Werner, M. R., and Salat, T., 1994, Use of vitrinite reflectance as a maturation indicator in the Brookian petroleum system of the Alaskan North Slope: *American Association of Petroleum Geologists Annual Meeting Abstracts,* p. 192-193.

Lanphere, M. A., Dalrymple, G. B., and Turrin, B. D., eds., 1994, Abstracts of the Eighth International Conference on Geochronology, Cosmochronology, and Isotope Geology, June 5-11 1994, Berkeley California USA: *U.S. Geological Survey Circular* 1107.

Larson, P. B., Cunningham, C. G., and Naeser, C. W., 1994, Large-scale alteration effects in the Rico paleothermal anomaly, Southwest Colorado: Elston, Wolfgang E., et al. *Economic Geology and the Bulletin of the Society of Economic Geologists*, v. 89, p. 1769-1779.

Laubacher, G., and Naeser, C. W., 1994, Fission-track dating of granitic rocks from the Eastern Cordillera of Peru, evidence for Late Jurassic and Cenozoic cooling: *Journal of the Geological Society [of London],* v. 151, Part 3, p. 473-483.

Marshallsea, S. J., Duddy, I. R., Green, P. F., and Hegarty, K. A., 1994, Integration of apatite fission track analysis and vitrinite reflectance in thermal history reconstruction of sedimentary basins: *American Association of Petroleum Geologists Annual Meeting Abstracts,* p. 206.

May, S. J., Kelley, S. A., and Russell, L. R., 1994, Footwall unloading and rift shoulder uplifts in the Albuquerque Basin, their relation to syn-rift fanglomerates and apatite fission-track ages: *Geological Society of America Special Paper* 291, p. 125-134.

McCulloch, A. A., and Holliday, D. W., 1994, Discussion on Mesozoic cover over northern England, interpretation of apatite fission track data [discussion and reply]: *Journal of the Geological Society [of London],* v. 151, Part 4, p. 735-736.

Meigs, A. J., Burbank, D. W., and Beck, R. A., 1995, Middle-late Miocene (>10 Ma) formation of the Main Boundary thrust in the western Himalaya: Geology, v. 23, p. 423-426.

Menzies, M. A., Yelland, A., Baker, J., Blakey, S., Chazot, G., Al-Kadasi, M., and Rundle, C., 1994, Evolution of the Red Sea volcanic margin, a multi-isotopic approach, *in* Lanphere, M. A., Dalrymple, G. B., and Turrin, B. D., eds., Abstracts of the Eighth International Conference on Geochronology, Cosmochronology, and Isotope Geology, June 5-11 1994, Berkeley California USA: *U.S. Geological Survey Circular* 1107, p. 216.

Michel, T., and Eugster, O., 1994, Primitive xenon in diogenites and plutonium-244-fission xenon ages of a diogenite, howardite, and eucrites: *Meteoritics*, v. 29, p. 593-606.

Mitchell, M. M., Hill, K. C., Foster, D. A., O'Sullivan, P. B., and Duddy, I. R., 1994, Thermal variations in a passive margin, from apatite fission track analysis in the western Otway Basin, Australia, *in* Lanphere, M. A., Dalrymple, G. B., and Turrin, B. D., eds., Abstracts of the Eighth International Conference on Geochronology, Cosmochronology, and Isotope Geology, June 5-11 1994, Berkeley California USA: *U.S. Geological Survey Circular* 1107, p. 221.

Miskovsky, J. C., and Gibert, E., 1994, L'Atome au service de la prehistoire, le cadre geologique de l'homme fossile a la lumiere des datations et des donnees isotopiques [The use of the atom for prehistory; the geologic framework of fossil man in light of isotopic dating and data]: *Memoires de la Societe Geologique de France Nouvelle Serie,* n. 162, p. 71-84.

Moore, T. E., Fuis, G. S., O'Sullivan, P. B., and Murphy, J. M., 1994, Evidence of Laramide age deformation in the Brooks Range, Alaska: *Geological Society of America Abstracts with Programs,* v. 26, n. 7, p. 383.

Mull, C. G., Reifenstulh, R. R., Harris, E. E., and Crowder, R. K., 1995, Neocomian source and reservoir rocks in the western Brooks Range and Arctic Slope, Alaska: *Geological Society of America Abstracts with Programs,* v. 79, n. 4, p. 105.

Naeser, N. D., 1993, Apatite fission-track analysis in sedimentary basins - a critical appraisal, *in* Doré, A. G., Augustson, J. H., Hermanrun, C., Stewart, D. J., and Sylta, Ø., eds. Basin Modeling: Advances and Applications, Proceedings of the Norwegian Petroleum Society Conference, 13-15 March 1991, Stavanger, Norway: *Norwegian Petroleum Society (Norsk Petroleums-forening/NPF), Special Pub-lication No.* 3, Elsevier, Amsterdam, p. 147-160.

Noble, W. P., Foster, D. A., and Gleadow, A. J. W., 1994, Extensional tectonic evolution of eastern Tanzania from apatite fission track thermochronology, *in* Lanphere, M. A., Dalrymple, G. B., and Turrin, B. D., eds., Abstracts of the Eighth International Conference on Geochronology, Cosmochronology, and Isotope Geology, June 5-11 1994, Berkeley California USA: *U.S. Geological Survey Circular* 1107, p. 235.

Neubauer, F., Dallmeyer, R. D., Dunkl, I., and Schirnik, D., 1995, Late Cretaceous exhumation of the metamorphic Gleinalm Dome, Eastern Alps; kinematics, cooling history and sedimentary response in a sinistral wrench corridor: *Tectonophysics,* v. 242, p. 79-98.

Nishiwaki-Nakajima, N., 1992, Correlation of sed-imentological and micropaleontological data of the Quaternary Osaka Group, with special reference to its sedimentation processes: *29th International Geological Congress Abstracts*, v. 29, p. 266.

O'Brien, A., 1994, Annealing characteristics of spontaneous and induced fission tracks in the Fish Canyon Tuff zircon, *in* Lanphere, M. A., Dalrymple, G. B., and Turrin, B. D., eds., Abstracts of the Eighth International Conference on Geochronology, Cosmochronology, and Isotope Geology, June 5-11 1994, Berkeley California USA: *U.S. Geological Survey Circular* 1107, p. 235.

Oreskes, N., Rhodes, A. L., Rainville, K., Sheets, S., Espinoza, S., and Zentilli, M., 1994, Origins of magnetite deposits at El Laco, Chile; new evidence from field studies, fluid inclusions, stable isotopes, and fission track analysis: Geological *Society of America Abstracts with Programs,* v. 26, n. 7, p. 379.

O'Sullivan, A. J., O'Sullivan, P. B., and Gleadow, A. J. W., 1994, Apatite fission track study of a vertical profile trough the Bogong High Plains, Victoria, Australia, *in* Lanphere, M. A., et al.: *U.S. Geological Survey Circular* 1107, p. 236.

O'Sullivan, P. B., 1994, Cenozoic uplift and thermal history of the North Slope foreland basin, Northern Alaska and northwestern Canada, *in* Lanphere, M. A., Dalrymple, G. B., and Turrin, B. D., eds., Abstracts of the Eighth International Conference on Geochronology, Cosmochronology, and Isotope Geology, June 5-11 1994, Berkeley California USA: *U.S. Geological Survey Circular* 1107, p. 237.

Pillans, B. J., Roberts, A. P., Wilson, G. S., Abbott, S. T., and Alloway, B. V., 1994, Magnetostratigraphic, lithostratigraphic and tephrostratigraphic constraints on lower and middle Pleistocene sea-level changes, Wanganui Basin, New Zealand: *Earth and Planetary Science Letters,* v. 121, p. 81-98.

Rahn, M. K. W., Hurford, A. J., Mullis, J., Erdelbrock, K., and Frey, M., 1994, A multi-methodological study from the Glarus Alps, eastern Switzerland to unravel the metamorphic and uplift history: *Geological Society of America Abstracts with Programs*, v. 26, n. 7, p. 480.

Reynolds, J. H., Idleman, B. D., Hernandez, R. M., and Naeser, C. W., 1994, Preliminary chrono-stratigraphic constraints on Neogene tectonic activity in the Eastern Cordillera and Santa Barbara System, Salta Province, NW Argentina: *Geological Society of America Abstracts with Programs,* v. 26, n. 7, p. 503.

Richard, S. M., Smith, C. H., Kimbrough, D. L., Fitzgerald, P. G., Luyendyk, B. P., and McWilliams, M. O., 1994, Cooling history of the northern Ford Ranges, Marie Byrd Land, West Antarctica: *Tectonics,* v. 13, p. 837-857.

Roden-Tice, M. K., Garver, J. I., and Brandon, M. T., 1994, Rapid erosional denudation in the Olympic Mountains of the Cascade forearc, Washington State: *Geological Society of America Abstracts with Programs,* v. 26, n. 7, p. 459.

Rohrman, M., van der Beek, P., and Andriessen, P., 1994, Syn-rift thermal structure and post-rift evolution of the Oslo Rift (Southeast Norway), new constraints from fission track thermochron-ology: *Earth and Planetary Science Letters,* v. 127, p. 39-54.

Rohrman, M., van der Beek, P. A., Andriessen, P. A. M., and Cloetingh, S., in press, Meso-Cenozoic morphotectonic evolution of southern Norway: Neogene domal uplift inferred from apatite fission track thermochronology: Tectonics, paper 95TC00088.

Rowe, S. P., Day, H. W., and Naeser, C. W., 1994, Metamorphism of the northern Sierra Nevada, constraints from zircon fission track analysis: *Geological Society of America Abstracts with Programs,* v. 26, n. 2, p. 86.

Rowley, P. D., Mehnert, Harald H., Naeser, C. W., Snee, L. W., Cunningham, C. G., Steven, T. A., Anderson, J. J., Sable, E. G., and Anderson, R. E., 1994, Isotopic ages and stratigraphy of Cenozoic rocks of the Marysvale volcanic field and adjacent areas, west-central Utah: *U.S. Geological Survey Bulletin* 2071.

Samuel, A., Harbury, N. A., and Jones, M. E., 1994, Basin development and inversion on an oblique-slip convergent margin, Nias Island, western Indonesia: *American Association of Petroleum Geologists Bulletin,* v. 78, p. 1160.

Seidl, M. A., and Weissel, J. K., 1994, Erosion across a rifted continental margin; an example from SE Australia: *Geological Society of America Abstracts with Programs,* v. 26, n. 7, p. 241.

Shane, P. A. R., 1994, A widespread, early Pleistocene tephra (Potaka Tephra, 1 Ma) in New Zealand, character, distribution, and implications: *New Zealand Journal of Geology and Geophysics,* v. 37, p. 25-35.

Shane, P. A. R., Black, T. M., and Westgate, J. A., 1994, 1994, Isothermal plateau fission-track chronology for early Pleistocene sedimentation and tectonism at a convergent plate boundary, Cape Kidnappers, New Zealand: *Geological Society of America Abstracts with Programs,* v. 26, n. 7, p. 258.

Shane, P., Black, T., and Westgate, J., 1994, Isothermal plateau fission-track ages from a paleomagnetic excursion in the Mamaku Ignimbrite, New Zealand, and implications for late Quaternary stratigraphy: *Geophysical Research Letters*, v. 21, p. 1695-1698.

Shane, P., Froggatt, P., Black, T., and Westgate, J., 1995, Chronology of Pliocene and Quaternary bioevents and climatic events from fission-track ages on tephra beds, Wairarapa, New Zealand: *Earth and Planetary Science Letters*, v. 130, p. 141-154.

Shimeld, J. W., and Williamson, M. A., 1993, Fault-related fluid migration in the Jeanne d'Arc Basin, offshore Eastern Canada: *Geological Association of Canada and Mineralogical Association of Canada; Joint Annual Meeting Program with Abstracts,* p. 96.

Shinjoe, H., and Tagami, T., 1994, Cooling history of the Sanbagawa metamorphic belt inferred from fission track zircon ages: *Tectonophysics,* v. 239, p. 73-79.

Snee, L. W., Naeser, C. W., Naeser, N. D., Todd, V. R., and Morton, D. M., 1994, Preliminary $^{40}Ar/^{39}Ar$ and fission-track cooling ages of plutonic rocks across the Peninsular Ranges Batholith, So. California: *Geological Society of America Abstracts with Programs,* v. 26, n. 2, p. 94.

Sobel, E., Dumitru, T. A., Hendrix, M. S., Graham, S. A., and Zhou, D., 1994, Cenozoic uplift and unroofing of the Tian Shan, western China: *Geological Society of America Abstracts with Programs,* v. 26, n. 7, p. 463.

Stuewe, K., White, L., and Brown, R., 1994, The influence of eroding topography on steady-state isotherms, application to fission track analysis: *Earth and Planetary Science Letters*, v. 124, p. 63-74.

Thomson, S. N., 1994, Fission track analysis of the crystalline basement rocks of the Calabrian Arc, southern Italy, evidence of Oligo-Miocene late-orogenic extension and erosion: *Tectonophysics* , v. 238, p. 331-352.

Thomson, S. N., 1994, Fission-track analysis and provenance studies in Calabrian Arc sedimentary rocks, southern Italy: *Journal of the Geological Society [of London]*, v. 151, Part 3, p. 463-471.

Wang S., and Kang T., 1994, A study on standardization of fission track dating: *Scientia Geologica Sinica,* v. 29, p. 78-84.

Williams, G. E., 1994, Acraman, a major impact structure from the Neoproterozoic of Australia: *Geological Society of America Special Paper* 293, p. 209-224.

Yamada, R., Tagami, T., and Nishimura, S., 1995, Confined fission-track length measurement of zircon, assessment of factors affecting the paleotemperature estimate: *Chemical Geology,* v. 119, p. 293-306.

Yamada, R. , Tagami, T., and Nishimura, S., 1994, Fission-track annealing in zircon, confined track length analysis and the Arrhenius plot, *in* Lanphere, M. A., Dalrymple, G. B., and Turrin, B. D., eds., Abstracts of the Eighth International Conference on Geochronology, Cosmochronology, and Isotope Geology, June 5-11 1994, Berkeley California USA: *U.S. Geological Survey Circular* 1107, p. 358.

Yelland, A. J., Menzies, M. A., and Hurford, A. J., 1994, Exhumation of the Red Sea and Gulf of Aden rift-flanks, fission track contrasts within the volcanic and non-volcanic margins of the Yemen Republic, *in* Lanphere, M. A., Dalrymple, G. B., and Turrin, B. D., eds., Abstracts of the Eighth International Conference on Geochronology, Cosmochronology, and Isotope Geology, June 5-11 1994, Berkeley California USA: *U.S. Geological Survey Circular* 1107, p. 360.

Zartman, R. E., and Abston, Carl C., 1995, National Geochronological Data Base: *U.S. Geological Survey Digital Data Series* 0014.

Call for Contributions to the November 1995 *On Track* issue 11

Dear Fellow Fission Tracker:

The next issue will be printed in November, 1995 and **we are looking for contributions.** We welcome contributions of virtually any kind, including descriptions of new lab techniques, reviews of useful products, news and gossip, raving editorials about what all the other labs are doing wrong (or right), corrections of errors that appeared in the previous issue, meeting announcements, job openings, cartoons, and descriptions of what you are doing in your research.

On Track always includes a list of **Recent Fission-Track Papers**. If you know of a paper that was published recently, or that is in press and should be published in the near future, please send it in. The **Short Tracks: News** section allows all of us to keep up with fission "trekking" around the globe. *On Track* also includes an **International Fission-Track Directory** in each May issue. If you are about to move, have moved, or know of someone who has moved, please inform me so the directory can be updated.

If you would like to contribute, send the final text and figures before the **DEADLINE, 15 October, 1995**. If it is a lengthy article, let me know the title and length as soon as possible. Please send a paper copy of your contribution and a 3.5 inch **Macintosh(TM) compatible disc** with the text saved in Microsoft Word. If you can't send a Macintosh compatible disc, send a 3.5 inch IBM compatible disc in Word, or WordPerfect. Contributions can also be sent electronically. Send all contributions for the next issue of *On Track* to:

Ruth Siddell , On Track Editor
Fission Track Research Group
Geological Sciences
University College London
Gower St.
London WC1E-6BT, United Kingdom
Tel.: 0171-380-7777 office ext. 2758, lab ext. 2418
Fax: 0171-388-7614,
E-mail: r.siddell@acl.ac.uk

1995 DIRECTORY OF THE INTERNATIONAL FISSION-TRACK COMMUNITY

This directory is published solely for the information of fission-track researchers. It is neither a comprehensive directory including all fission-track researchers nor an official document endorsing the scientific stand of individuals by the fission-track community. We provide here an update to the initial directory prepared by Rasoul Sorkhabi with the hope that we have accounted for the changes in addresses that have occurred since the last release of the directory.

Andriessen, Paul A.M.
Laboratorium voor Isotopen Geologie
Faculteit der Aardwetenschappen
Vrije Universiteit de Boelelaan 1085
1081 HV Amsterdam, *The Netherlands*
Arne, Dennis C.
Ph.D. (Melbourne, 1990)
Department of Geology
University of Ballarat, P.O. Box 663
Ballarat, Victoria 3352, *Australia*
Tel.: 61-53-279-290, Fax: 61-53-279-144
Email: DCA@fs3.ballarat.edu.au
Bal, K.D.
Ph.D. (Kurukshetra, 1982)
KDM Institute of Petroleum Exploration
Oil & Natural Gas Corporation Ltd.
Dehradun , *India*
Baldwin, Suzanne
Department of Geosciences
University of Arizona
Tucson, AZ 85721, *United States of America*
Balestrieri, Maria Laura
Dipartimento di Scienze della Terra
via S. Maria, 53
56126 Pisa, *Italy*
Bergman, Steven C.
Ph.D. (Princeton, 1982)
ARCO Exploration and Production Technology
2300 W. Plano Parkway
Plano, TX 75075-8499, *United States of America*

Tel.: 1-214-754-6264, Fax: 1-214-754-6807
E-mail: dprscb@arco.com
Bigazzi, Giulio, Ph.D.
Instituto di Geochronologia e Geochimica Isotopica, CNR
via Cardinale Maffi, 36
56127 Pisa, *Italy*
Tel.: +39-50-560430/560110, Fax: +39-50-589008
Blythe, Ann E.
Ph.D. (Cornell, 1992)
Department of Geological Sciences, University of California
Santa Barbara, CA 93106, *United States of America*
Tel. 1-805-893-4530
E-mail: blythe@magic.ucsb.edu
Boettcher, Stefan S.
M.S. (North Carolina, 1990)
Department of Geological Sciences
University of Texas at Austin
Austin, TX 78712, *United States of America*
Tel.: 1-512-471-8547, Fax: 1-512-471-9425
E-mail: sboett@maestro.geo.utexas.edu
Bojar, Ana-Voica
Institut fuer Geologie and Palaeontologie
Karl-Franzens Universitaet
Heinrichstrasse 26
A-8010 Graz, *Austria*
Fax: 43-316-382885
Brandon, Mark T.
Department of Geology and Geophysics
Kline Geology Laboratory
P.O. Box 6666
Yale University
New Haven, CT 06511, *United States of America*
Braun, Jean-Jacques
CREGU BP23
54501 Vandoeuvre-les-Nancy
Cedex, *France*
Brix, Manfred R.
Ph.D. (Bonn, 1981)
Ruhr-Universitaet Bochum,
Fakultat fuer Geowissenschaften
Institut fuer Geologie
Postfach 102148
Universitaetsstrasse 150
D-W 4630 Bochum 1, *Germany*
Tel.: 0049-234-700-3236, Fax: 0049-234-709-4179
Brown, Roderick W.
Ph.D. (La Trobe, 1992)
Department of Geology
La Trobe University
Bundoora, Victoria 3083, *Australia*
Tel.: 61-3-479-1274, Fax: 61-3-479-1272
E-mail: georwb@lure.latrobe.edu.au
Burchart, Jan
Institute of Geological Sciences
Polish Academy of Sciences
Zwirki i Wigury 93
02-089 Warsaw, *Poland*
Carlson, William D.
Ph.D. (University of California, Los Angeles, 1980)
Department of Geological Sciences
University of Texas at Austin
Austin, TX 78712, *United States of America*
Tel.: 1-512-471-4770, Fax: 1-512-471-9425
E-mail: wcarlson@ccwf.cc.utexas.edu
Carpena, Joelle
DSD-SCS-LGCA
C.E.N. Cadarache
13108 Saint Paul lez Durance CDX, *France*
Carpenter, Stephen B.
A505 Administration Bldg.
National Institute of Standards and Technology
Gaithersburg, MD 20841, *United States of America*
Carter, Andrew
Department of Geology
Birkbeck College
7-15 Gresse Street
London W1P 1PA, *United Kingdom*
Chambaudet, Alain
Universite de Franche-Comte
U.F.R. des Sciences et des Techniques
Laboratoire de Microanalyses Nucleaires
16 route de Gray

F-25030 Besancon Cedex, *France*
Cloos, Mark
Ph.D. (University of California, Los Angeles, 1981)
Department of Geological Sciences
University of Texas at Austin
Austin, TX 78712, *United States of America*
Tel.: 1-512-471-4170, Fax: 1-512-471-9425
Email: cloos@maestro.geo.utexas.edu
Corrigan, Jeff D.
Ph.D. (University of Texas at Austin, 1990)
ARCO Exploration and Production Technology
2300 W. Plano Parkway
Plano, TX 75075, *United States of America*
Tel.: 1-214-509-4090
Email: dprjdc@arco.com
Coyle, David A.
Ph.D. (La Trobe)
Hirschstrasse 8/1
D-7465 Geislingen, *Germany*
Tel.: +49-7433-6338
E-mail: dcoyle@goanna.mpi-hd.mpg.de
Crowley, Kevin, D.
Ph.D. (Princeton University, 1982)
Associate Director
Board on Radioactive Waste Management
National Academy of Sciences
National Research Council
2001 Wisconsin Avenue, N.W.
Washington, D.C. 20007, *United States of America*
Tel.: 1-202-334-3066, Fax: 1-202-334-3077
Email: KCROWLEY@NAS.EDU
Danhara, Tohru
Kyoto Fission-Track Co.
Umezukita-machi 33
Ukyo-ku, Kyoto 615, *Japan*
Tel.: 81-75-881-2103, Fax: 81-75-871-8044
De Corte, Frans
Institute for Nuclear Sciences
University of Gent
Proeftuinstraat 86
B-9000 Gent, *Belgium*
Decker, John E.
Ph.D. (Stanford, 1980)
ARCO Alaska, Inc.
ANO 772, 700 G.St.,
Anchorage, AK 99501, *United States of America*
Tel.: 1-907-265-1521, Fax: 1-907-265-1515
De Wispelaere, Antoine
University Gent, Institute for Nuclear Sciences
Proeftuinstraat, 86
B-9000 Gent, *Belgium*
Tel.: +32-9-264-6627, Fax: +32-9-264-6699
Email: dewispelaere@inwchem.rug.ac.be
de Wit, M.C.J.
American Research Laboratories (Pty) Limited
PO Box 106 Crown Mines 2025
Johannesburg, *South Africa*
Dodson, Martin H., Ph.D.
Department of Earth Sciences
University of Leeds
Leeds, LS2 9JT, *United Kingdom*
Dokka, Roy K.
Department of Geology
Louisiana State University
Baton Rouge, LA 70803, *United States of America*
Tel.: 1-504-388-2975
Donelick, Raymond A.
Donelick Analytical, Incorporated
4819 Katy-Hockley Road
Katy, TX 77493 *United States of America*
Tel.: 1-713-371-3346, Fax: 1-713-371-0133
Email: 72762.1465@compuserve.com
Duddy, Ian R.
Ph.D. (Melbourne, 1983)
Geotrack International, P.O. Box 4120
Melbourne University
Victoria 3052, *Australia*
Tel.: +61-3-344-7214, Fax: +61-3-347-5938
Dumitru, Trevor A.
Ph.D. (Melbourne, 1989)
Department of Geology, Stanford University
Stanford, CA 94305-2115, *United States of America*

Tel.: 1-415-725-1328, Fax: 1-415-725-2199
E-mail: trevor@pangea.stanford.edu
Duncan, Alasdair
BP Exploration
PG8G (2/4S W10)
301 St. Vincent Street
Glasgow, G2 5DD, Scotland, *United Kingdom*
Dunkl, Istvan
Ph.D. (Budapest, 1991)
Hungarian Academy of Sciences
Laboratory for Geochemical Research, H-1112
Budapest, Budaorsi ut 45, *Hungary*
Tel.: +36-1-185-1781, Fax: +36-1-185-1781
E-mail: h6580dun@ella.hu
Durrani, Saeed A.
Ph.D.; D.Sc. (Birmingham, 1978)
School of Physics and Space Research,
University of Birmingham,
Birmingham B15 2TT, *United Kingdom*
Tel.: +44-21-414-4691/4655, Fax: +44-21-414-4693
Eby, G. Nelson
Ph.D. (Boston, 1971)
Department of Earth Sciences
University of Massachusetts
Lowell, MA 01854, *United States of America*
Tel.: 1-508-934-3907, Fax: 1-508-934-3003
E-mail: ebyn@woods.ulowell.edu
Evarts, Russ
U.S. Geological Survey
345 Middlefield Road
Mail Stop 999
Menlo Park, CA 94025, *United States of America*
Fayon, Annia K.
M.S. (University of Texas, Dallas, 1989)
Department of Geology
Arizona State University
Tempe, AZ 85287-1404, *United States of America*
Tel.: 1-602-965-3971/5081, Fax: 1-602-965-8102
E-mail: agakf@asuvm.inre.asu.edu
Fisher, David E.
Ph.D. (Florida, 1958)
Department of Geological Sciences
University of Miami
Miami, FL 33124-0401, *United States of America*
Tel.: 1-305-284-3254, Fax: 1-305-284-4258
Fitzgerald, Paul G.
Ph.D. (Melbourne, 1987)
Department of Geosciences
University of Arizona,
Tucson, AZ 85721, United *States of America*
Tel.: 1-602-621-4052, Fax: 1-602-621-2672
E-mail: kiwi@sapphire.geo.arizona.edu
Fleischer, Robert L.
Ph.D. (Harvard, 1956)
Department of Earth and Environmental Sciences
West Hall
Rensselaer Polytechnic Institute
Troy, NY 12180-3590, *United States of America*
Tel.: 1-518-276-8523, Fax: 1-518-276-8627
General Electric Company
P.O. Box 8, Schenectady, NY 12301, USA
Tel.: 1-518-387-6238, Fax: 1-518-387-7007
Foland, Sara S.
Amoco Production Company
1670 Broadway
P.O. Box 800
Denver, CO 80201, *United States of America*
Foster, David A.
Ph.D. (SUNY, Albany, 1989)
VIEPS, Department of Geology
La Trobe University
Bundoora, Victoria 3083, *Australia*
Tel.: 61-3-479-1516, Fax: 61-3-479-1272
E-mail: dfoster@mojave.latrobe.edu.au
Fwgenschun, Bernhard
M.Sc. (Innsbruck, Austria, 1989)
Geologisches Institut
ETH Zurich 8092, *Switzerland*
Tel.: 0041-1-256-3637
Galbraith, Rex F., Ph.D.
Department of Statistical Science
University College, Gower Street

London, WC1E 6BT, *United Kingdom*
Ganzawa, Yoshiro
Ph.D. (Hokkaido, 1983)
Hokkaido University of Education
1-2 Hachiman-cho
Hakodate, 040, *Japan*
Tel.: 81-0138-41-1121, Fax: 81-0138-42-3982
Garver, John I.
Ph.D. (Washington, 1989)
Department of Geology
Union College
Schenectady, NY 12308, *United States of America*
Tel.: 1-518-370-6517, Fax: 1-518-370-6789
E-mail: garverj@gar.union.edu
George, Pete, Ph.D.
Department of Geological Sciences
University of Texas at Austin
Austin, TX 78712, *United States of America*
Gibson, Helen
M.Sc. (Melbourne, 1993)
Geotrack International
P.O. Box 4120
Melbourne University
Victoria 3052, *Australia*
Tel.: +61-3-344-7214, Fax: +61-3-347-5938
Giegengack, Robert
Geology Department
University of Pennsylvania
Philadelphia, PA 19104-6316, *United States of America*
Giger, Matthias
Ph.D. (1991, Berne)
Muehlemathweg 21
5034 Suhr (Argovia), *Switzerland*
Tel.: 0041-64-314-312
Gleadow, Andrew J. W.
Ph.D. (Melbourne, 1974)
Department of Geology
La Trobe University
Bundoora, Victoria 3083, *Australia*
Tel.: 61-3-479-2649, Fax: 61-3-479-1272
Green, Paul F.
Ph.D. (Birmingham)
Geotrack International
P.O. Box 4120
Melbourne University
Victoria 3052, *Australia*
Tel.: +61-3-344-7214, Fax: +61-3-347-5938
Grist, Alexander
M.Sc. (Dalhousie, 1990)
Department of Earth Sciences
Dalhousie University
Halifax, Nova Scotia, B3H 3J5, *Canada*
Tel.: 1-902-494-2372, Fax: 1-902-494-6889
Grivet, Manuel
Universite de Franche-Comte
U.F.R. des Sciences et des Techniques
Laboratoire de Microanalyses Nucleaires
16, route de Gray
F-25030 Besancon Cedex, *France*
Hadler, Julio C.
Depto. Raios Cosmicos e Cronologia
Inst de Fisica - UNICAMP, CP 6165
13081 Campinas, SP, *Brazil*
Hansen, Kirsten
Ph.D. (1986)
Geologisk Centralinstitut
Oster Volgrade 10, DK-1350
Kobenhavn K, *Denmark*
Tel.: 45-33-11-22-32 ext. 379, Fax: 45-33-11-46-37
Harrison, Mark T.
Department of Earth and Space Sciences
University of California, Los Angeles
Los Angeles, CA 90024, *United States of America*
Hasebe, Noriko
M.Sc. (Kyoto)
Department of Geology and Mineralogy
Faculty of Science
Kyoto University
Kyoto 606, *Japan*
Tel.: 81-75-753-4153, Fax: 81-75-753-4189
Hashemi-Nezhad, S.R.
Ph.D. (Birmingham)

Department of Physics
Faculty of Science
Tabriz University
Tabriz, *Iran*
Hayashi, Masao
Kyushu Sangyo University
Fukuoka 813, *Japan*
Tel.: 092-673-5883, Fax: 092-673-5899
Hegarty, Kerry A.
Ph.D. (Columbia, 1985)
Geotrack International
PO Box 4120
Melbourne University
Victoria 3052, *Australia*
Tel.: 61-3-344-7214, Fax: 61-3-347-5938
Hejl, Ewald R.
Ph.D. (Max-Planck Institut)
Institut fuer Geologie und Palaontologie der Universitaet Salzburg, Hellbrunnerstrasse 34/III
A-5020 Salzburg, *Austria*
Tel.: 0662-8044-5437/5400, Fax: 0662-8044-5010
Hill, Kevin C.
Ph.D. (Melbourne, 1989)
VIEPS, Department of Geology
La Trobe University
Bundoora, Victoria 3083, *Australia*
Tel.: 61-3-479-1273, Fax: 61-3-479-1272
E-mail: geokch@lure.latrobe.edu.au
Honda, Teruyyki, Ph.D.
Atomic Energy Research Laboratory
Musashi Institute of Technology
Kawasaki 215, *Japan*
Hurford, Anthony J., Ph.D.
Research School of Geological Sciences
University and Birbeck Colleges, Gower Street
London WC1E 6BT, *United Kingdom*
Tel.: +41-71-380-7704 or +44-71-387-7050 (Lab)
Fax: +44-71-388-7614
Issler, Dale R.
Ph.D. (Dalhousie, 1987)
Geological Survey of Canada
Institute of Sedimentary and Petroleum Geology
3303-33rd St., NW
Calgary, Alberta, T2L 2A7, *Canada*
Tel.: 1-403-292-7172, Fax: 1-403-292-5377
Ito, Hisatoshi
M.Sc. (Kyoto, 1988)
Central Research Institute of Electric Power Industry
1646 Abiko City, Chiba, *Japan*
Tel.: 81-471-82-1181, Fax: 81-471-83-2962
Iwano, Hideki
Kyoto Fission-Track Co.
Umezukita-machi 33
Ukyo-ku, Kyoto 615, *Japan*
Tel.: 81-75-881-2103, Fax: 81-75-871-8044
Johnson, Mark
U.S. Geological Survey
345 Middlefield Road
Mail Stop 999
Menlo Park, CA 94025, *United States of America*
Jonckheere, R.
Laboratorium voor Aardkunde
Universiteit Gent
Krijgslaam 281
B-9000, Gent, *Belgium*
Kamp, Peter J., Ph.D.
Department of Earth Sciences
University of Waikato
Hamilton 2001, *New Zealand*
Tel.: 64-7-856-2889, Fax: 64-7-856-0115
Kasuya, Masao
Kyoto Fission-Track Co.
Umezukita-machi 33
Ukyo-ku, Kyoto 615, *Japan*
Tel.: 81-75-881-2103, Fax: 81-75-871-8044
Kelley, Shari A.
Department of Geological Sciences
Southern Methodist University
Dallas, TX 75275, *United States of America*
Kendrick, Dan
M.S. (Utah State University)
VIEPS, Department of Geology
La Trobe University

Bundoora, Victoria 3083, *Australia*
Tel.: 61-3-479-1273, Fax: 61-3-479-1272
E-mail: geordk@lure.latrobe.edu.au
Ketcham, Richard
Ph.D. (University of Texas at Austin, 1995)
Department of Geological Sciences
University of Texas at Austin
Austin, TX 78712, *United States of America*
Tel.: 1-512-471-5763, Fax: 1-512-471-9425
E-mail: richk@maestro.geo.utexas.edu
Kohn, Barry P.
Ph.D. (Victoria Univ. of Wellington, NZ, 1973)
VIEPS, Department of Geology
La Trobe University
Bundoora, Victoria 3083, *Australia*
Tel.: 61-3-479-1516/1274, Fax: 61-3-479-1272
E-mail: geobpk@lure.latrobe.edu.au
Koshimizu, Satoshi
Institute for Atomic Energy
Rikkyo University
Nagasaka 2-5-1, Yokosuka, 240-01, *Japan*
Tel.: 81-468-56-3131, Fax: 81-468-56-7576
Kowallis, Bart Joseph
Ph.D. (Wisconsin, 1981)
Department of Geology
Brigham Young University
Provo, UT 84602, *United States of America*
Tel.: 1-801-378-2467, Fax: 1-801-378-2265
Krochmal, Michael
Autoscan Systems Pty. Ltd.
P.O. Box 112
Ormond, Victoria 3204, *Australia*
Lal, Nand
Ph.D. (Kurukshetra)
Department of Physics
Kurukshetra University
Kurukshetra-132119, *India*
Laslett, Geoff M., Ph.D.
CSIRO, Division of Mathematics and Statistics
Private Bag 10
Clayton, Victoria 3168, *Australia*
Lewis, Cherry L.E.
Geotrack International (UK)
30 Upper High Street
Thames, OX9 3EX, *United Kingdom*
Linn, Jon
M.S. (University of Kansas)
University of Kansas
Department of Geology
120 Lindley Hall
Lawrence, KS 66045, *United States of America*
E-mail: jklinn@kuhub.cc.ukans.edu
Maerk, E.
Hohrere technische Bundeslehr-
und Versuchsanstalt Anichstr. 26-28
A 6020 Innsbruck, *Austria*
Maerk, T. D.
Abt. f. Kernphysik u. Gaselektronik
Institut f. Experimentalphysik
Leopold Franzens Universitaet
A 6020 Innsbruck, *Austria*
Marshallsea, Susan
Ph.D. (Melbourne, 1988)
Geotrack International
P.O. Box 4120
Melbourne University
Victoria 3052, *Australia*
Tel.: +61-3-344-7214, Fax: +61-3-347-5938
Matsuda, Takaaki
Himeji Institute of Technology
2167, Shosha Himeji
Hyogo 671-22, *Japan*
Maze, Will B.
Ph.D. (1983, Princeton)
Exxon Production Research
P.O. Box 2189
Houston, TX 77252-2189, *United States of America*
Tel.: 1-713-965-7223, Fax: 1-713-965-7951
McCorkell, Robert
CANMET, Mineral Technology Branch
Energy, Mines and Resources
555 Booth Street

Ottawa, Ontario K1A 0G1, *Canada*
McCulloh, Thane H.
Ph.D. (University of California, Los Angeles, 1952)
7136 Aberdeen
Dallas, TX 75230, *United States of America*
Tel.: 1-214-691-6809
Meyer, Arnaud J.
ELF AQUITAINE-CSTJF L1/010
64018 Pau Cedex, *France*
Miller, Donald S.
Ph.D. (Columbia)
Department of Earth and Environmental Sciences
Rensselaer Polytechnic University
Troy, NY 12180-3590, *United States of America*.
Tel.: 1-518-276-8523, Fax: 1-518-276-8627
E-mail: don-miller@mts.rpi.edu
Miller, Elizabeth L.
Ph.D. (Rice, 1977)
Department of Geology, Stanford University
Stanford, CA 94305-2115, *United States of America*
Tel.: 1-415-723-1149, Fax: 1-415-725-2199
E-mail: miller@pangea.stanford.edu
Mitchell, Melinda M.
B.Sc. Hons. (La Trobe)
C/O Department of Geology
La Trobe University
Bundoora, Victoria 3083, *Australia*
Tel.: 61-3-479-1274, Fax: 61-3-479-1272
E-mail: geomm@lure.latrobe.edu.au
Moore, Marilyn
Ph.D. (Melbourne, 1982)
Geotrack International
P.O. Box 4120
Melbourne University
Victoria 3052, *Australia*
Tel.: +61-3-344-7214, Fax: +61-3-347-5938
Mora, Jorge
Department of Geological Science
College of Science and Mathematics
Earth Sciences 351
State University of New York
Albany, NY 12222, *United States of America*
Mora, Jorge
Escuela de Geologia
Minas y Geofisica
Facultad de Ingenieria
Universidad Central de Venezuela
Caracas, *Venezuela*
Murphy, John M.
M.S. (Alaska, 1989)
Department of Geology and Geophysics
University of Wyoming
Laramie, WY 82071, *United States of America*
Tel.: 1- 307-766-5435
E-mail: geojm@plains.uwyo.edu
Naeser, Charles W.
Ph.D. (Southern Methodist Univ., Dallas, 1967)
U.S. Geological Survey
Mail Stop 908
12201 Sunrise Valley Dr.
Reston, VA 22092, *United States of America*
Tel.: 1-703-648-6964, Fax: 1-703-648-6937
E-mail: cnaeser@gccmail.cr.usgs.gov
Naeser, Nancy D.
Ph.D. (Victoria Univ. Wellington, 1973)
U.S. Geological Survey
Mail Stop 908
12201 Sunrise Valley Dr.
Reston, VA 22092, *United States of America*
Tel.: 1-703-648-5328, Fax: 1-703-648-5310
Nishimura, Susumu, D.Sc.
Department of Geology and Mineralogy
Faculty of Science
Kyoto University
Kyoto 606, *Japan*
Tel.: 81-75-753-4150, Fax: 81-75-753-4189
Noble, Wayne P.
B.Sc. Hons. (La Trobe)
C/O Department of Geology
La Trobe University
Bundoora, Victoria 3083, *Australia*
Tel.: 61-3-479-2630, Fax: 61-3-479-1272

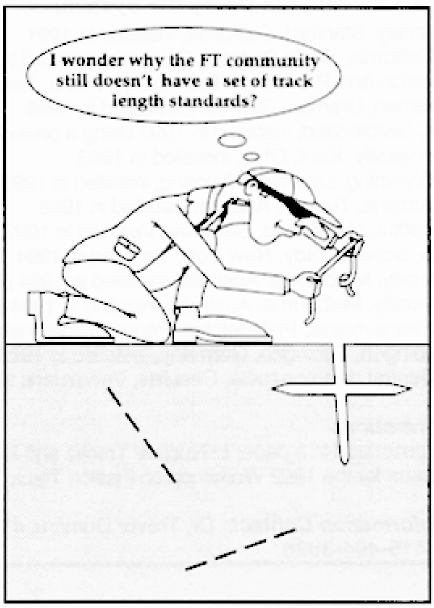
E-mail: georwpn@lure.latrobe.edu.au
Oddone, Massimo
Dipartimento di Chimica Generale
viale Taramelli, 12
27100 Pavia, *Italy*
Olesch, Martin
Ph.D. (Wurzburg, 1986)
University Bremen
FB 5 Geowissenschaften
Postfach 330 440
2800 Bremen, 00071-00 *Germany*
Tel.: +49-421-2183940, Fax: +49-421-2183993
Omar, Gomaa I.
Geology Department
University of Pennsylvania
Philadelphia, PA 19104, *United States of America*
O'Sullivan, Andrea J.
B.Sc. Hons. (La Trobe, 1989)
VIEPS, Department of Geology
La Trobe University
Bundoora, Victoria 3083, *Australia*
Tel.: 61-3-479-1274, Fax: 61-3-479-1272
E-mail: geoajo@lure.latrobe.edu.au
O'Sullivan, Paul B.
Ph.D. (La Trobe, 1993)
Department of Geology
La Trobe University
Bundoora, Victoria 3083, *Australia*
Tel.: 61-3-9479-3517, Fax: 61-3-9479-1272;
E-mail: pos@mojave.latrobe.edu.au
Pagel, Maurice
Dr. es Sciences (Nancy, 1981)
CREGU, B.P. 23
54501 Vandoeuvre-Les-Nancy, *France*
Tel.: 33-83-44-19-00, Fax: 33-83-44-00-20
Pan , Yun
Department of Geological Sciences
University of SUNY at Albany
NY 12222, *United States of America*
Paul, Tracy A.
Ph.D. (Arizona State Univ., 1993)
Department of Geology
Arizona State University
Tempe,. AZ 85287-1404, *United States of America*
Tel.: 1-602-965-0538/5081, Fax: 1-602-965-8102
E-mail: agtxp@asuacad
Pengji, Zhai
Institute of High Energy Physics
Academia Sinica
P.O. Box 2732
Beijing 100080, *People's Republic of China*
Perelygin, V. P. Dr.
Flerov Laboratory of Nuclear Reactions
Joint Institute for Nuclear Research, Dubna
Head Post Office, Box 79
101 000 Moscow
Russian Federation
Petford, N.
Bullard Lab.
Department of Earth Sciences
University of Cambridge
Madingly Rise
Cambridge, CB3 0DZ, *United Kingdom*
Poupeau, Gerard R.
Doctor d'Etat (Paris, 1974)
Universite Joseph Fourier
Institut Dolomieu
15, Rue Maurice - Gignoux
38031 Grenoble Cedex, *France*
Tel.: 33-76-63-59-30, Fax: 33-76-87-82-43
Price, P. Buford
Ph.D. (Virginia, 1958)
Department of Physics
University of California
Berkeley, CA 94720, *United States of America*
Tel.: 1-510-642-4982, Fax: 1-510-643-8497
E-mail: price@lbl.qov
Puch, Thomas
Insitute fuer Geologie and Palaeontologie
Karl-Franzens Universitaet
Heinrichstrasse 26
A-8010 Graz, *Austria*

Fax: 43-316-382885
Qvale, Henning
(Oslo, 1978)
Institute for Energy Technology
P.O. Box 40
N 2007, Kjeller, *Norway*
Tel.: +47-63-80-61-22, Fax: +47-63-81-55-53
E-mail: hq@varney.ite.no
Ratschbacher, Lothar
Ph.D. (Graz, Austria)
Institut fuer Geologie der
Universitaet Tubingen
D-7400 Tubingen, *Germany*
Tel.: +49-707-1295240, Fax: +49-707-1296990
E-mail: epifr010mailserv.zdv.uni-tuebingen.de
Ravenhurst, Casey E.
Department of Geology and Geography
University of Massachusetts
Amherst MA 01003, *United States of America*
E-mail: CRAVENHU@smith.smith.edu
Raza, Asaf
M.Sc. (Punjab, Pakistan)
C/O Department of Geology
La Trobe University
Bundoora, Victoria 3083, *Australia*
Tel.: 61-3-479-1274, Fax: 61-3-479-1272
E-mail: geoar@lure.latrobe.edu.au
Rebetez, Michel
Universite de Franche-Comte
U.F.R. des Sciences et des Techniques
Laboratoire de Microanalyses Nucleaires
16, route de Gray
F-25030 Besancon Cedex, *France*
Redfield, Thomas F.
M.S. (Western Washington)
Department of Geology
Arizona State University
Tempe, AZ 85287-1404, *United States of America*
Tel.: 1-602-965-3971/5081, Fax: 1-602-965-8102
E-mail: agtfr@asuvm.inre.asu.edu
Roden-Tice, Mary, K.
Ph.D. (Rensselaer, 1989)
Center for Earth & Environmental Science
SUNY Plattsburgh
Plattsburgh, NY 12901, *United States of America*
Tel.: 1-518-564-2019, Fax: 1-518-564-3152
Saini, Hari Singh
Department of Radiometric Dating
Birbal Sahni Institute of Paleobotany
53 University Road
Post Box 106
Lucknow 226 007, *India*
Sandhu, Amanjit S.
Ph.D. (Guru Nanak Univ., India)
Department of Physics
Guru Nanak University
Amritsar 143005, *India*
Seward, Diane
Ph.D. (Wellington, 1974)
Department Erdwissenschaften
ETH-Zentrum
CH-8092, Zurich, *Switzerland*
Tel.: 0041-1-252-2227, Fax: 0041-1-252-7008
Siddell, Ruth
Ph.D. (University College London, 1994)
Fission Track Research Group
Geological Sciences
University College London
Gower St
London WC1E-6BT, *United Kingdom*
Tel.: 0171-380-7777 ext. 2758 for office, ext. 2418 for lab
Fax: 0171-388-7614
E-mail: r.siddall@ucl.ac.uk
Sleadon, Andrew Jan
Ph.D. (Melbourne, 1974)
Department of Geology
La Trobe University
Bundoora, Victoria 3083, *Australia*
Tel.: 61-3-479-2649, Fax: 61-3-479-1272
E-mail: seoajs@lure.latrobe.edu.au
Sobel, Ed
Ph.D. (Stanford, 1995)

Laboratoire de Geologie
CNRS Ura 10
5 rue Kessler
63038 Clermont-Ferrand cedex *France*
Fax: (33) 73 34 67 44
Email: sobel@opgcf5.univ-bpclermont.fr
Sohrabi, Mehdi, Ph.D.
Radiation Protection Department
Atomic Energy Organization of Iran
P.O. Box 14155-4494
Tehran, *Iran*
Sorkhabi, Rasoul B.
Ph.D. (Kyoto, Japan, 1991)
Department of Geology
Arizona State University
Tempe, AZ 85287-1404, *United States of America*
Tel.: 1-602-965-9852/5081, Fax: 1-602-965-8102
E-mail: idrbs@asuvm.inre.asu.edu
Steckler, Michael S.
Ph.D. (Columbia, 1981)
Lamont-Doherty Geological Observatory
Palisades, NY 10964, *United States of America*
Tel.: 1-914-365-8479, Fax: 1-914-365-0718
E-mail: steckler@lamont.idgo.columbia.edu
Stiberg, Jan-Petter
Institute for Energy Technology
P.O. Box 40, N 2007
Kjeller, *Norway*
Tel.: +47-63-80-61-22, Fax: +47-63-81-55-53
Stockmal, Glen S.
Ph.D. (Brown Univ., 1984)
Geological Survey of Canada
Institute of Sedimentography and Petroleum Geology
3303-33rd Street, N.W.
Calgary, Alberta T2L 2A7, *Canada*
Tel.: 1-403-292-7173, Fax: 1-403-292-5377
Storzer, Dieter
Museum d'histoire naturelle
Laboratoire de Mineralogie
61 rue Buffon,
75005 Paris, *France*
Stump, Edmund
Ph.D. (Ohio State Univ., 1976)
Department of Geology
Arizona State University
Tempe, AZ 85287-1404, *United States of America*
Tel.: 1-602-965-3971/5081, Fax: 1-602-965-8102
E-mail: ateds@asuacad.
Sumi, Tomoaki
M.Sc. (Kyoto)
Fuel Resources Department
Geological Survey of Japan
1-1-3 Higashi, Tsukuba,
Ibaraki 305, *Japan*
Tel.: 81-298-54-3674, Fax: 81-298-54-3533
Summerfield, Michael Anthony
Ph.D. (Oxford, 1978)
Department of Geography
School of Earth Sciences
University of Edinburgh
Edinburgh EH8 9XP, *United Kingdom*
Tel.: +44-31-650-2519
Suzuki, Masao
Rikkyo University
34-1 Nishi Ikebukuro
3-Chome, Toshima-ku
Tokyo 171, *Japan*
Tagami, Takahiro
Ph.D. (Kyoto)
Department of Geology and Mineralogy
Faculty of Science
Kyoto University
Kyoto 606, *Japan*
Tel.: 81-75-753-4153, Fax: 81-75-753-4189
Talbot, James
1709 Overlook Drive,
Grapevine, TX 76051, *United States of America*
Thomson, Stuart
Institut fuer Geologie
Ruhr-Universitaet Bochum
Universitaetsstrasse 150
P.O. Box 102148

Bochum 44721, *Germany*
Vance, Joseph, A.
Department of Geological Sciences
University of Washington
Seattle, WA 98195, *United States of America*
Van den Haute, Peter
Geologisch Instituut
Rijiks Universiteit
B-9000 Gent, *Belgium*
Tel: +32 (0) 9 264/4592 or 6627, Fax: +32 (0) 9 264 4984
E-mail: FTWORK@inwchem.rug.ac.be
Vercoutere, Caroline
Geologisch Instituut
Rijiks Universiteit
B-9000 Gent, *Belgium*
Virk, H. S.
Department of Physics
Guru Nanak Dev University
Amritsar-143005, *India*
Wadatsumi, Kiyoshi
Department of Geosciences
Faculty of Science
Osaka City University
3-3-138 Sugimoto
Sumiyoshi-ku
Osaka 558, *Japan*
Wagner, Gunther A.
Ph.D. (Heidelberg, 1967)
Max-Planck-Institut fuer Kernphysik
Saupfercheckweg, D-6900
Heidelberg, *Germany*
Wagner, Martin
Institut fuer Petrographie und Geochemie
Universitaet Karlsruhe
Kaiserstr. 12
D-7500 Karlsruhe, *Germany*
Walgenwitz, Frederic
ELF AQUITAINE-CSTJF L1/010
64018 Pau Cedex, *France*
Walker, J. D.
Ph.D. (Massachusetts Institute of Technology, 1985)
Department of Geology
University of Kansas
120 Lindley Hall
Lawrence, KS 66045-2969, *United States of America*
Walker, Robert M.
Ph.D. (Yale, 1954)
McDonnell Center for the Space Sciences
Campus Mail 1105
Washington University
1 Brookings Drive
St. Louis, MO 63130, *United States of America*
Tel.: 1-314-935-6225, Fax: 1-314-935-6219
E-mail: brw@wuphys.wustl.edu
Walter, Bob
Institute of Human Origins
2453 Ridge Road
Berkely, CA 94709-1211, *United States of America*
Tel.: 1-510-845-0333, Fax: 1-510-845-9453
Email: bwalter@iho.org
Waraich, R. S.
Ph.D. (Kurukshetra, 1978)
KDM Institute of Petroleum Exploration
Oil & Natural Gas Corporation LTD.
Dehradun, *India*
Watanabe, Koichiro
Department of Mining
Faculty of Engineering
Kyushu University,
36 Hakozaki, Fukuoka 812, *Japa*n
Tel.: 81-92-641-1101 ext. 5677
Weiland, Richard J.
M.A. (University of Texas at Austin, 1993)
Department of Geological Sciences
University of Texas at Austin
Austin, TX 78712 *United States of America*
Tel.: 1-512-471-8547, Fax: 1-512-471-9425
E-mail: rweiland@maestro.geo.utexas.edu
Westgate, John A., Ph.D.
Department of Geology
University of Toronto
Scarborough Campus

Scarborough, Ontario
M1C 1A4, *Canada*
Yamashita, Tohru
Kyoto Fission-Track Co.
Umezukita-machi 33
Ukyo-ku, Kyoto 615, *Japan*
Tel.: 81-75-881-2103, Fax: 81-75-871-8044
Yegingil, Zehra
Cukurova University
Arts-Sciences Faculty
Physics Department
P.O. Box 171, 01330 Adana, *Turkey*
Zhao, Yunlong
Beijing Research Institute of Uranium Geology
P.O. Box 764
Beijing 100029, *Peoples Republic of China*
Zeitler, Peter K.
Ph.D. (Dartmouth, 1983)
Department of Earth & Environmental Sciences
Lehigh University
31 Williams Drive
Bethlehem, PA 18015-3188, *United States of America*
Tel.: 1-215-758-3671, Fax: 1-215-758-3677
E-mail: pkz0@lehigh.edu
Zentilli, Marcos,
Ph.D. (Queen's Univ., Canada, 1974)
Department of Earth Sciences
Dalhousie University
Halifax, Nova Scotia, B3H 3J5, *Canada*
Tel.: 1-902-494-3873, Fax: 1-902-494-6889
E-mail: zentilli@ac.dal.ca
Zimmerman, Robert Allen
Ph.D. (Pennsylvania, 1976)
U.S. Geological Survey, MS 905
Box 25046, Federal Center
Denver, CO 80225, *United States of America*
Tel.: 1-303-236-5626, Fax: 1-303-236-5603
E-mail: rzimm@greenwood.ct.usgs.gov. internet
Zuffa, Gian G.
Dipartimento di Scienze Geologiche
Universita di Bologna
via Zamboni 67
40137 Bologna, *Italy*
Tel.: 39-51354536
E-mail: zuffa@Dogon.geomin.unibo.it



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- Stanford University, Stanford, California, installed in 1991
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- ARCO Exploration and Production Technology, Plano, Texas, installed in 1992
- Universität Bremen, Bremen, Germany, installed in 1993
- E.T.H., Zürich, Switzerland, installed in 1993 using a preexisting stage
- Kent State University, Kent, Ohio, installed in 1993
- University of Wyoming, Laramie, Wyoming, installed in 1993
- University of Arizona, Tucson, Arizona, installed in 1993
- Max-Planck-Institut, Heidelberg, Germany, installed in 1993 using a preexisting stage
- Union College, Schenectady, New York, installed in 1994
- Monash University, Melbourne, Australia, installed in 1994 using a new Zeiss stage
- La Trobe University, Melbourne, Australia, installed in 1994 using two new Zeiss stages
- University of Pennsylvania, Philadelphia, Pennsylvania, installed in 1995
- Universität Tübingen, Tübingen, Germany, installed in 1995
- Universidad Central de Venezuela, Caracas, Venezuela, installed in 1995

Detailed Information:
The system is described in a paper in Nuclear Tracks and Radiation Measurements, vol. 21, p. 575-580, Oct. 1993 (proceedings issue for the 1992 Workshop on Fission Track Thermochronology held in Philadelphia).

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