

国家攀登计划项目

现代地壳运动与 地球动力学研究

中国地壳运动
全球背景研究

STUDY ON THE GLOBAL BACKGROUND
OF THE CRUSTAL MOTION
OF CHINA CONTINENT

1

上海科技教育出版社

**“现代地壳运动与地球动力学研究”
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分册主编:黄璠 研究员

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中国地壳运动全球背景研究

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总 序

近年来,由于空间测量技术的发展,地面定位精度已达厘米,甚至毫米级,使监测当时或近乎实时的地壳运动成为可能。中国大陆是全球地壳运动最复杂的地区之一,由此引发的自然灾害十分频繁。研究中国地壳运动,对于灾害预测和地球科学的研究都是很重要的。

由中国科学院、国家地震局、国家测绘局和总参测绘局有关单位共同发起和承担的国家重大基础研究(攀登)项目“现代地壳运动和地球动力学研究”于1991年立项,历时十载,于今年结题。

本项目基于空间测量技术来测定和研究我国大陆的地壳运动及其动力学,对全球背景和重要地区分别加以研究,并以重力场和水准面的研究为补充,测量技术与数据处理方法的研究为支持,共分为六个子课题:

1. 中国地壳运动全球背景研究
2. 中国大陆主要活动带现今地壳运动及动力学研究
3. 青藏高原岩石圈现今变动与动力学研究
4. 中国沿海地区陆地与海平面垂直运动研究
5. 中国地区重力场与大地水准面研究
6. 现代地壳运动的空间测量技术和数据处理方法研究

十年来,在有关单位研究人员的共同努力下,本项目已取得许多成果,给出了中国大陆地壳运动的初步图像。本项目是大地测量、地球物理、地质、地震及天文的多学科交叉,是百人联合共同奋斗的结果,它不仅促进了国家重大科学工程“中国地壳运动监测网”(CMONC)的建立,也推动了“亚太空间地球动力学”(APSG)国际合作计划的建立。

作为本项目的首席科学家,我衷心感谢国家科技部的鼎力支持,衷心感谢各位研究人员和管理人员的通力合作。本论文集六个子课题分别编为六卷,刊载本项目的重要成果和论文,谨供同行参阅。

叶叔华

二〇〇一年七月

前言

“中国地壳运动的全球背景研究”是以叶叔华院士为首席科学家的国家攀登计划——“现代地壳运动和地球动力学研究”的一个二级课题。

中国地壳运动是在全球地壳运动的背景场中发生的,需相对于全球场来描述,并受全球场制约。因此中国地壳运动的研究离不开全球地壳运动背景场的研究;离不开对全球板块的构造学、运动学和动力学的研究;也离不开影响全球地壳运动的地球整体运动及地球其他圈层运动变化的相互作用的考虑。中国地壳运动的全球背景的研究内容主要是:利用空间技术精确测定和研究中国大陆相对于全球框架的现实运动,研究这种运动的动力学机制,精化地球动力学参考坐标系,研究地球整体运动(自转与极移)及其与地球各圈层内大尺度运动的相互关系。

开展本课题的研究不仅对我国现代地壳运动的研究,对完善全球现代地壳运动的实测和连结,对全球地壳构造理论的检核和研究具有十分重要的意义,而且对人们了解地球内部的物理结构和迁移规律,对地球环境变迁的认识,以及对地球科学的预测能力的提高都具有深远的意义。

本课题的实施可分为两个阶段,跨越“八五”和“九五”。第一阶段先后由赵铭研究员、郑大伟研究员为课题组长,马宗晋院士为课题副组长,第二阶段由黄城研究员和朱耀仲研究员负责。在第一阶段共发表论文 150 余篇,并选择其精华,编辑出版了专集《天地之间——天文地球动力学论文集(1991~1996)》,第二阶段在前期工作的基础上,课题研究内容结合国际上的研究热点稍作了调整,课题组成员也扩展包含了大气、海洋与地球内部动力学的领域。第二阶段经全体课题组人员的努力,取得了丰硕的成果,共发表学术论文 146 篇,学术报告 52 篇,获国家与省部的奖三项,取得的重要研究进展有:

1. 全球地壳运动和地球参考系

(1) 地球南北半球的非对称性研究

通过对地球内部热散矢量、地震波速度分布、多种地幔地震层析成像数据分析和用空间大地测量数据的检测,进一步证实了地球南北半球的非对称性。

(2) 地球质心运动

用 SLR 观测数据,初步发现地心位置有 5 毫米量级的季节性变化,并发现地球质心存在长期北移趋势,可能的机制是岩石圈板块运动和地幔对流。

2. 空间技术监测地球和各圈层物质的运动

(1) 与第六课题组合作,使 SLR、VLBI 数据处理的能力有了质的提高,VLBI 解算地球自转参数的结果已达到国际先进水平(名列前三),SLR 的定轨精度已与国际最先进的美国空间研究中心(CSR)水平相当。

(2) 为促进星载 GPS 气象学用于区域性天气预报和大气变化的研究,在国际上首次提出了用通约轨道方法解决 GPS/LEO 卫星掩星技术中的掩星点位置控制的问题。

3. 地球自转及其与地球各圈层物质运动的关系

(1) 地球自转与海、气相互作用

- 在国际上首先提出北大西洋的海气涛动过程可能是极移年际时间尺度的一种新的激发源,综合北大西洋涛动和 El Niño/南方涛动可更好地解释年际尺度的地极运动。

- 除了给出地球自转年际速率变化可提供 El Niño 前兆外,最近分析了 1982~1983 年和 1997~1998 年期间的两次强 El Niño 事件对地球自转变化的影响,揭示了多时间尺度大气振荡对地球自转年际速率异常变化激发的合成作用。

- 在 20 年、周年及多年时间尺度上建立了能描写地球自转变化和大气角动量变化关系的动力系统,在季、年尺度上建立了能描写地球自转变化对低纬大气和海洋运动影响的动力方程组。

(2) 地球自转理论

在二阶地球动力学扁率精度下,建立了包含固体内核、流体外核、粘滞地幔、海洋和大气的微椭非刚体地球章动理论。该章动理论被列为 IAU 2000 章动模型的四个参考模型之一。

(3) 地球内部的动力学

在行星大气和地球内部磁流体动力学研究方面:(A)在国际上首次对描述旋转球形流体运动的 Poincare 方程给出了一般显式解:首次证明了旋转小粘性球形流体内部耗散积分为零,得出旋转小粘性流体球中波动耗散应该主要发生在流体边界层内的重要结论。(B)对行星地球大气运动中的方向交替的快速平均流提出了由缓慢移动的地转波的弱非线性相互作用生成的新理论。

本论文集主要反映了上述第二阶段的研究进展与成果,并精选了第一阶段若干优秀的论文,共收集论文 88 篇。希望通过本论文集的出版促进学术交流,推进本课题所反映的交叉学科的发展。

本论文集之所以能出版,除了因全体课题组成员奋发努力外,也与项目首席科学家叶叔华院士、马宗晋院士以及攀登项目专家组和顾问组的全体专家的关心、指导和鼓励分不开的,在此我们代表课题组全体人员表示由衷的感谢,同时对上海天文台的周瑞仙女士以及上海科技教育出版社在出版本书过程中的帮助与支持表示我们诚挚的谢意。

黄 斌 朱耀仲

2001 年 11 月

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