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Abstract

After a gap of nearly two decades since the Magsat mission in 1980, the dedicated low-orbit potential field mission CHAMP is now in the third of its seven year mission. Already, the new magnetic total intensity and vector data have yielded maps of the global crustal field of unprecedented accuracy and resolution. Here, we assess the value of these maps to infer deep crustal structure of regions overlain by younger cover. A GIS based modelling technique has been developed to model the various geological units of the continents starting from the geological map of the world. Depending upon the known rock types of the region, they are assigned a standard susceptibility value and using the global seismic crustal structure, a vertically integrated susceptibility (VIS) model is computed at each point of the region. Starting with this initial VIS model, the vertical field anomaly is computed at a satellite altitude of 400 km and compared with the corresponding CHAMP vertical field anomaly map. The first comparison is carried out against a model using the lateral extent of a cratonic region as given by published tectonic maps. In the subsequent modelling step, depending upon the extent of the observed anomaly pattern of that region, the surface geology is extended beneath the sediments until the recomputed map fits the observed magnetic anomaly map. Here, we focus on modelling results for the selected few provinces of the world where the initial model does not agree with the observed anomaly map. Similar modelling of CHAMP satellite magnetic anomalies can constrain the subsurface structure hidden by Phanerozoic cover in many parts of the world.

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List of Abbreviations and Symbols

VIS	Vertically Integrated Susceptibility
3SMAC	Global seismic model by Nataf and Ricard (1996)
CRUST5.1	Global seismic model by Mooney et al. (1998) (Resolution: 5^0 X 5^0)
CRUST2.1	Improved version of global seismic model CRUST5.1 (Resolution: 2^0 X 2^0)
CTD	Depth of the Curie-temperature isotherm
VRM	Viscous Remanent Magnetisation
GFZ	GeoForschungsZentrum
F	magnitude of the geomagnetic main field of the Earth (nT)
V_c	magnetic potential outside the Earth's core (v)
c	'core' of the Earth
I	inclination of the geomagnetic field (deg.)
D	declination of the geomagnetic field (deg.)
$\mathbf{M}$	magnetisation or (dipole moment per unit volume, A/m)
$d\tau'$	elemental volume over the Earth's surface (km^3)
dm'	magnetisation of the elemental volume $d\tau'$ (A-m^2)
$r'(r',\theta',\phi')$	source coordinates of the elemental volume $d\tau'$ (m)
$r(r,\theta,\phi)$	distance from the center of the Earth to the point of observation (m)
$dV(r,r')$	magnetic potential at point r (v)
$\chi(r')$	susceptibility at point r' (dimensionless in SI units)
$\tilde{\chi}(\theta',\phi')$	vertically integrated susceptibility (m)
$\tilde{M}(\theta',\phi')$	vertically integrated magnetisation (A)
d	thickness of the crust (m)
ds'	elemental surface area at the source (m^2)
r'	radial distance of the source from the Earth's center (m)
θ'	colatitude at the source (deg.)
ϕ'	longitude at the source (deg.)
r	radial position coordinate at the point of observation (m)
θ	colatitude at the point of observation (deg.)
ϕ	longitude at the point of observation (deg.)
R	$\lvert r-r'\rvert$ (m)
s_0	area of cell size at the equator (m^2)
μ_0	magnetic permeability of free space [$4\pi \cdot 10^{-7}$ Henry/m]

p_n^m, q_n^m	spherical harmonic coefficients of the VIS
g_n^m, h_n^m	Gauss coefficients of the Geomagnetic main field
G_N^M, H_N^M	Gauss coefficients of the crustal field
n	spherical harmonic degree of the main field
m	spherical harmonic order of the main field
N	degree of spherical harmonic expansion for the crustal field
M	order of spherical harmonic expansion for the crustal field
δ_{MN}	Kronecker delta
P_n^m	Legendre's associated functions
$V(r,\theta,\phi)$	magnetic potential at the point of observation (v)
B_r	component of the crustal magnetic field in radial direction (nT)
B_θ	component of the crustal magnetic field in colatitude direction (nT)
B_ϕ	component of the crustal magnetic field in longitude direction (nT)
B_z	vertical component of the crustal magnetic field (nT), positive downward