R003-P03
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拡張村上モデルにもとづく流動電位起源静電磁場と重力異常・磁気異常の比較

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EM fields due to SP based on the extended Murakami model compared with the gravity and the magnetic anomalies

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Extended Murakami Model (Ogawa, JpGU2022, hereafter referred to as EMM) which can calculate static electromagnetic fields due to the streaming potential in a cuboid region excited by homogeneous fluid flow in a porous conductive homogeneous half space representing a flat earth is an extended model of Murakami (1989). The EMM has advantages: assuming that the shape of the region where the streaming potential is excited is a cuboid instead of a rectangular plane, and making it possible to calculate the electromagnetic fields at arbitrary points outside the cuboid. By assuming that the shape of the region where the streaming potential is excited (hereafter referred to as SP anomaly) is a cuboid, the cuboid can also be regarded as the density and the magnetization anomalies. The present study attempts to compare static electromagnetic fields due to the SP anomaly together with the gravity and the magnetic anomalies due to the density and the magnetization anomalies assuming that the SP, density, and magnetization anomalies are identical in its region.

The Green's functions show that the spatial decay of the fields are reciprocally proportional to the square of the distance between the source and the observation point for main terms of the magnetic flux density and the scalar potential of the EMM and the gravity anomaly, while to the cube of the distance for the magnetic anomaly. The static electromagnetic fields due to the EMM depend on the electrical conductivity of the space: the scalar potential depends on the conductivity of the ground and the ratio of the conductivity in the air to that in the ground, while the magnetic flux density depends only on the ratio, in case that the magnetic permeability can be regarded to be homogeneous over the whole space. The boundary plays an important role for the static electromagnetic fields based on the EMM, which is different from the gravity anomaly which does not depend on the property of the space, and the magnetic anomaly based on realistically homogeneous magnetic permeability over the whole space.

In addition, due to the boundary of the electrical conductivity and the insulating air, the components of the static electromagnetic fields due to horizontal fluid flow are enhanced, while the magnetic flux density due to vertical fluid flow vanishes.

While Murakami model calculates the magnetic flux density due to fluid flow along a rectangular fault plane, the present study shows the calculation results of the static electromagnetic fields based on the EMM assuming a cuboid region representing a conduit of a volcano as the SP anomaly together with those of the gravity and the magnetic anomalies regarding the region as the density and the magnetization anomalies.

拡張村上モデル (Ogawa, JpGU2022、以下 EMM) は、村上モデル (Murakami, 1989) を拡張し、導電的半無限均質大地の中に想定した一様な間隙流体流による直方体領域に生じた流動電位による静電磁場を計算するモデルである。流動電位が生じる領域を矩形面から直方体に拡張する一方、直方体領域の外の任意の地点における電磁場を計算可能としている点に EMM の利点がある。異常体の領域を直方体としたことにより、この領域を間隙流体流による流動電位（以下、SP 異常）の発生領域とみなすだけでなく、密度異常領域、磁化異常領域とみなすことも可能である。そこで、SP 異常領域を同時に密度異常及び磁化異常の領域と見なした際の重力異常、磁気異常の計算結果と、EMM による静電磁場の計算結果との比較を本研究で試みた。

グリーン関数の表現より、場の空間減衰は EMM の磁束密度、電位の主要項と重力異常は源泉からの距離の 2 乗に反比例、磁気異常は距離の 3 乗に反比例する。また EMM では空間の電気伝導度に依存した電位及び磁束密度が生じる。電位は大地と大気の電気伝導度の比、及び大地の電気伝導度に依存するが、磁束密度は透磁率が全空間で一様と見なせれば大地と大気の電気伝導度の比にのみ依存する。空間を満たす物性量に依存しない重力異常や、現実的には透磁率が全空間でほぼ一様とみなせる場合の磁気異常とは異なり、EMM による静電磁場には境界が重要な役割を果たす。

また電気伝導度の境界面にあたる地表と絶縁的な大気により、EMM の静電磁場は水平間隙流体流に起因する成分は増幅され、鉛直間隙流体流に起因する成分は磁束密度については消失する。

村上モデルが矩形断層面に沿った間隙流体流に起因する磁束密度を計算したのに対し、本発表では火山の火道を模した直方体領域を SP 異常と想定した、EMM にもとづく静電磁場を計算した結果を、同領域を密度異常、磁化異常とみなして得られる重力異常、磁気異常の計算結果と共に示す。