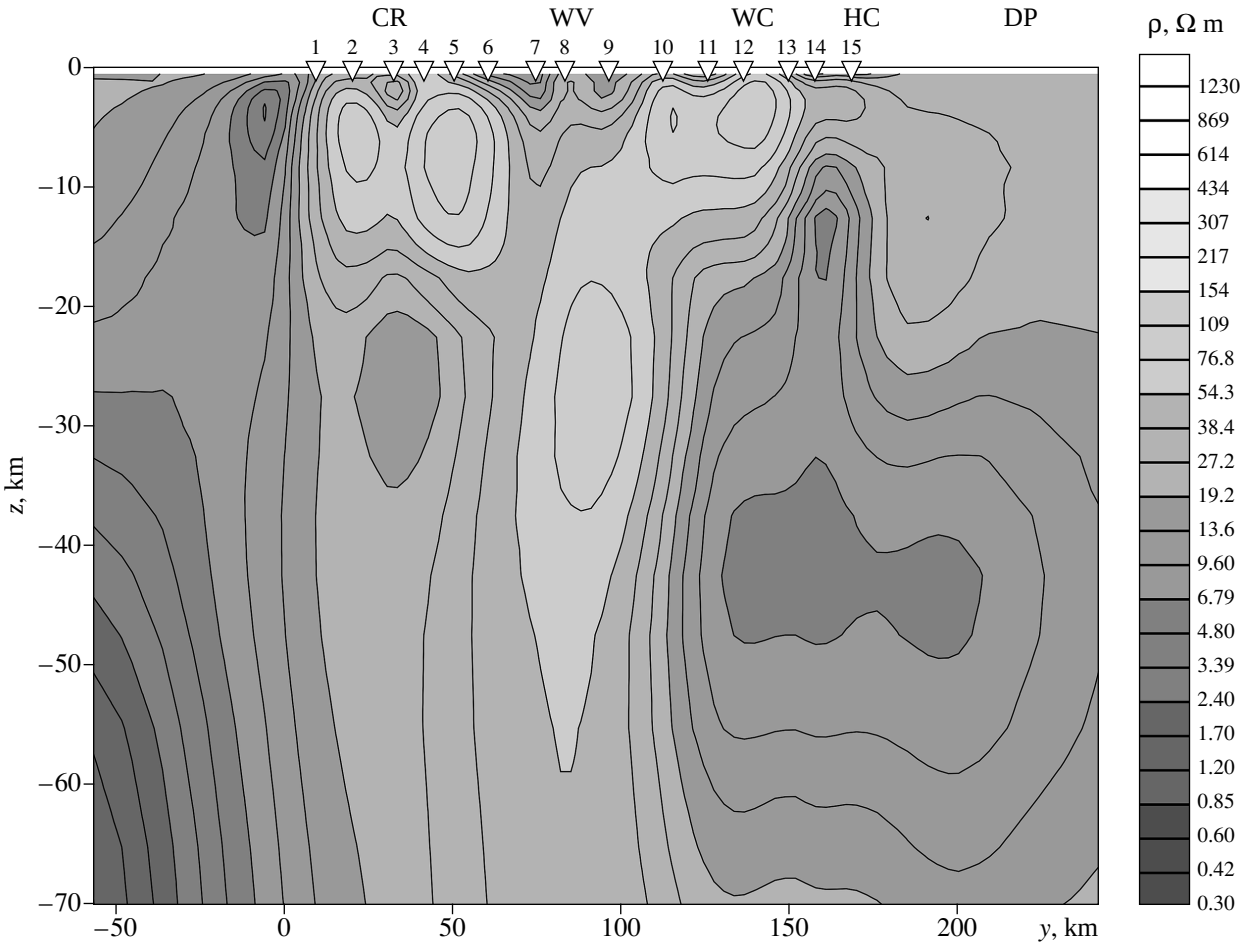

Fig. 18. The 2-D inversion of Re W_{zy}, Im W_{zy}, and $\varphi^{\parallel}$ performed with the use of the smoothing REBOCC program: CR, Coast Range; WV, Willamette Valley; WC, Western Cascades; HC, High Cascades; DP, Deschutes Plateau.

The EMSLAB-I model is open for criticism. A cold continental mantle contradicts current geodynamic ideas of the Cascadian subduction zone (compare the EMSLAB-I model with the predictive CASCADIA model shown in Fig. 16). Analysis of the EMSLAB-I model has shown that the TM-mode is weakly sensitive to variations in the electrical conductivity of the mantle and that the bimodal inversion alone, using both the TE and TM modes, can be effective in studying the asthenosphere [Berdichevsky *et al.*, 1992; Vanyan *et al.*, 2002].

Experiments on the bimodal interpretation of MTS and MVS data obtained in the Cascadian subduction zone resulted in the construction of the 2-D EMSLAB-II model (Fig. 17b). It was constructed with the use of the automatic inversion program INV2D-FG, optimizing resistivities on 20 blocks of a fixed geometry [Varentsov *et al.*, 1996]. An algorithm of parallel weighted inversion was applied to $\varphi^{\perp}$, Re W_{zy}, and Im W_{zy} (maximum weight), $\varphi^{\parallel}$ and $\rho^{\perp}$ (normal weight), and $\rho^{\parallel}$ (minimum weight). The EMSLAB-II model has much in common with EMSLAB-I. Both have the same oceanic asthenosphere, subducting slab, and crustal conducting layer. However, the EMSLAB-II plate joins the crustal conductor, and a conducting asthenosphere is present in the EMSLAB-II continental mantle. Thus, the geoelectric data have revealed partial melting in the continental mantle. The main drawback of the EMSLAB-II model is its sketchiness due to the limited possibilities of the INV2D-FG program.

Presently, the INV2D-FG program has given way to more efficient software tools designed for the automatic 2-D inversion of MVS and MTS data. These are the smoothing program REBOCC [Siripunvaraporn and Egbert, 2000] and the programs IGF-MT2D [Nowozynski and Pushkarev, 2001] and II2DC [Varentsov, 2002]. These programs enable the optimization of models containing 512 and more blocks of a fixed geometry and provide new possibilities for interpreting the EMSLAB experimental data [Vanyan *et al.*, 2002].

Three-dimensional model estimates obtained for the Pacific coast of North America and analysis of experimental field characteristics, induction arrows, and polar diagrams show that the regional structure along the Lin-

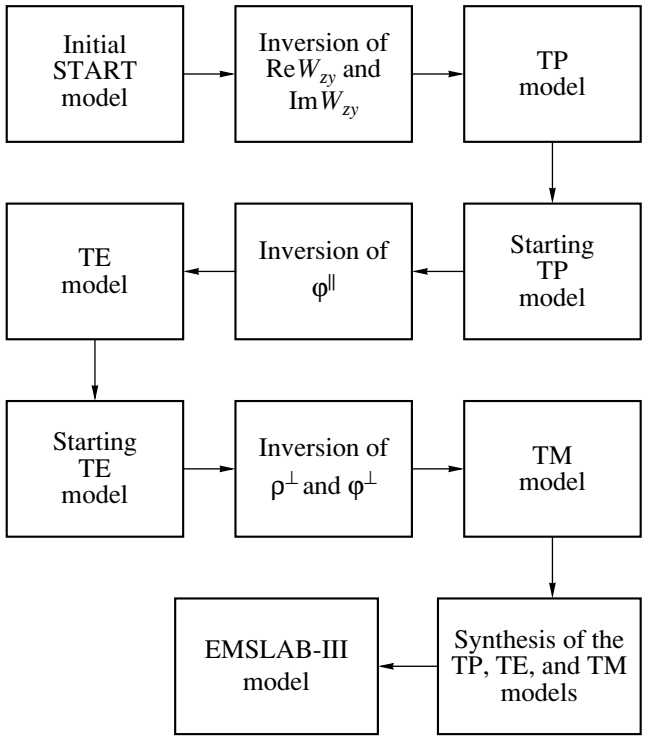

Fig. 19. Algorithm of interpretation of EMSLAB experimental data in the class of block models.

coln line is favorable for the 2-D interpretation of MVD and MTS data.

The interpretation consisted of three stages.

At the first stage, the 1-D inversion of short-period magnetotelluric (MT) curves (T = 0.01–100 s) was performed and an approximate geoelectric section of the continental volcanic-sedimentary cover was constructed to a depth of 3.5 km. This section agrees with the near-surface portion of the EMSLAB-I model [Wannamaker *et al.*, 1989b].

At the second stage, the REBOCC program was applied in experiments with 2-D smoothed inversion. With the complicated conditions of the Cascadian subduction zone, the parallel inversion of the TE- and TM-modes yielded whimsical alternation of low- and high-resistivity spots with a poor minimization of the misfit. It is difficult to recognize real structures of the subduction zone in these spots. The most interesting result was obtained from the partial inversion of Re W_{zy}, Im W_{zy}, and $\varphi^{\parallel}$ (Fig. 18). The western and eastern conducting zones identified here are separated by a T-shaped region of higher resistivity that can be associated with the subducting slab. An oceanic asthenosphere whose top can be fixed at a depth of about 30 km is recognizable in the western conducting zone. The eastern conducting zone coincides with the crust-mantle zone of wet melting in the predictive CASCADIA model shown in Fig. 16. It is noteworthy that the upper boundary of the eastern conductor closely resembles the topography of the crustal conducting zone in the EMSLAB-I and EMSLAB-II models shown in Fig. 17.

At the third, final stage, the method of partial inversions was applied and a new 2-D geoelectric model of the Cascadian subduction zone was constructed [Vanyan *et al.*, 2002]; this model was called EMSLAB-III. It was constructed with the use of the II2DC program [Varentsov, 2002], minimizing the model misfit in the class of media with a fixed geometry of blocks. The algorithm of interpretation consisting of partial inversions is illustrated in Fig. 19. The interpretation was conducted in the regime of testing hypotheses. We consider three hypotheses on the structure of the Cascadian subduction zone: (1) CASCADIA predictive model, (2) EMSLAB-I model, and (3) EMSLAB-II model.

The interpretation model is shown in Fig. 20a. The ocean floor topography and thicknesses of the seafloor, accretionary prism, and shelf sediments were specified from bathymetric and sedimentary thickness maps [Connard *et al.*, 1984a, 1984b]. The resistivities of the water, sediments, and oceanic crust were set at 0.3, 2, and 10 000 Ω m, respectively. The depth to the oceanic mantle and its resistivities were taken in accordance with the CASCADIA, EMSLAB-I, and EMSLAB-II models. The slab surface was constructed from seismic [Trehu *et al.*, 1994] and seismic tomography [Weaver and Michaelson, 1985; Rasmussen and Humphries, 1988] data. The structure of the volcanic-sedimentary cover was determined from the results of a 1-D inversion of short-period MT curves. The crust and mantle of

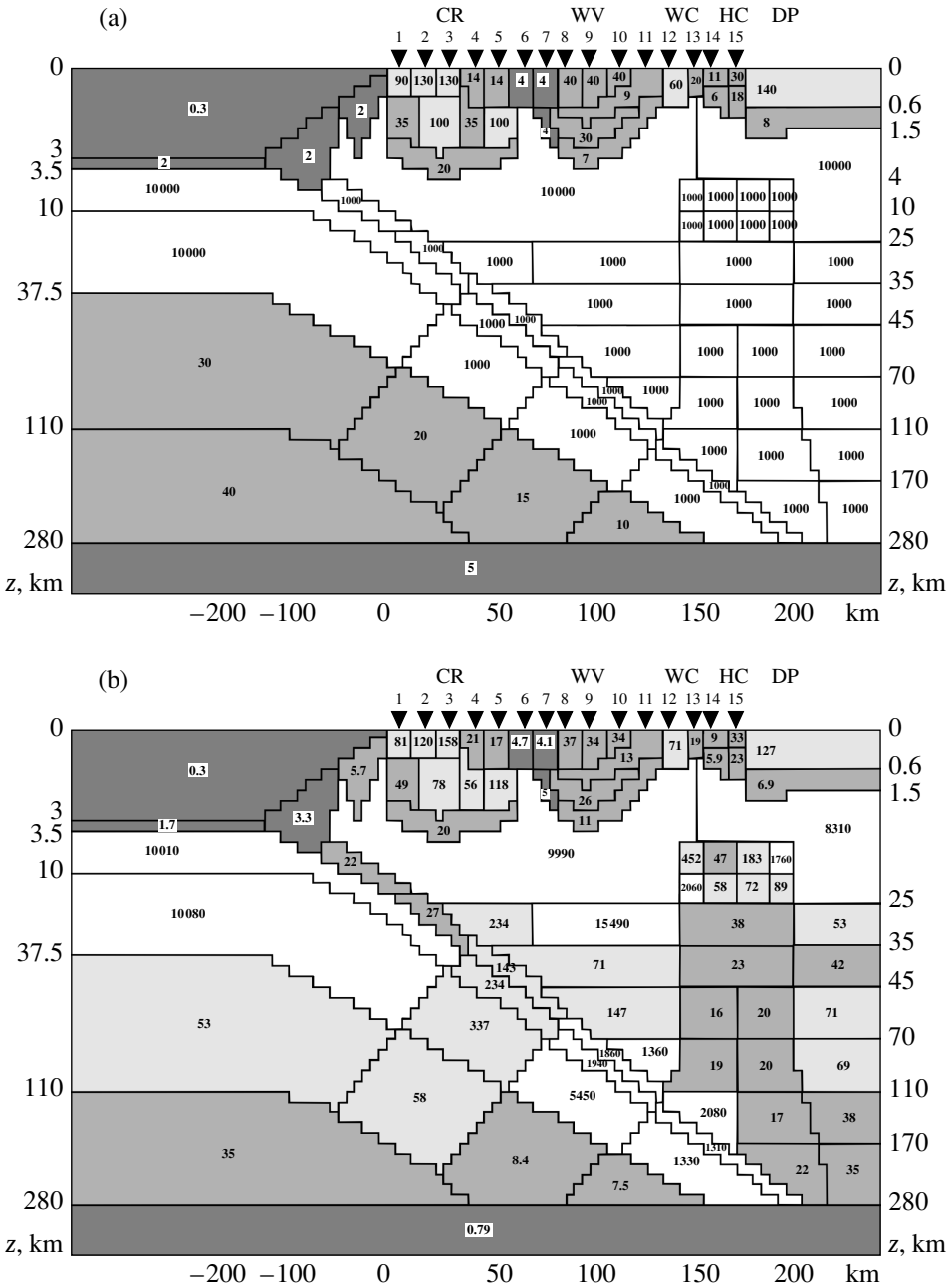

Fig. 20. Models obtained by partial inversions of the EMSLAB experimental data (resistivity values in units of Ω m are shown within blocks): (a) interpretation model (resistivity values of the initial START model are shown); (b) TP-2 model (inversion of $\mathrm{Re}\,W_{zy}$ and $\mathrm{Im}\,W_{zy}$); (c) TE model (inversion of $\varphi^{\parallel}$); (d) TM model (inversion of $\rho^{\perp}$ and $\varphi^{\perp}$). CR, Coast Range; WV, Willamette Valley; WC, Western Cascades; HC, High Cascades; DP, Deschutes Plateau.

the continent were divided into homogeneous blocks. The division density and block geometry were chosen with regard for the configuration of the eastern conducting zone, delineated with the help of the REBOCC program, and admitted a free choice of crust and mantle structures within the framework of the three hypotheses considered. A hypothesis best fitting the observed data is chosen automatically in the process of optimization of resistivities and minimization of misfits. The crust and mantle of the continent have a resistivity of 1000 Ω m in the starting START model constructed on the basis of the interpretation model. Below, we consider the successive partial inversions.

Inversion of $\mathrm{Re}\,W_{zy}$ and $\mathrm{Im}\,W_{zy}$. The START model was taken as the starting one. The TP model resulting from the inversion is shown in Fig. 20b. The tipper misfit (the rms deviation of model tippers from observed values) in this model is 5–10 times smaller than the tipper amplitude (the difference between the maximum and minimum tipper values), which is evidence of good